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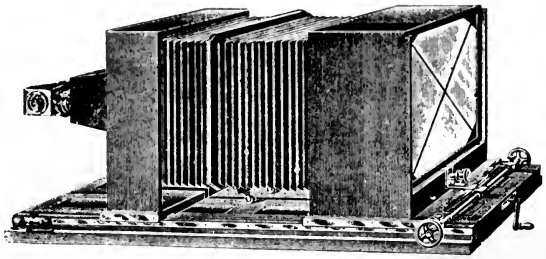

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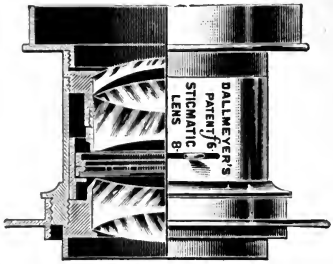

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PHOTO-MECHANICAL PROCESSES.

A Practical Guide to the Production of Letterpress Blocks in Line and in Tone, Photo-Lithography in Line and Tone, Collotype, and Photogravure.

BY

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CONTENTS.

PART V.

COLLOTYPE.

PART VI.

PHOTO-MECHANICAL PLATES FOR THREE-COLOUR PRINTING.

PART VII.

PHOTOGRAVURE.

THE AUTHOR.

PREFACE.

I HAVE re-written and corrected the greater part of this edition of "Photo-Mechanical Processes" with a view to bringing it up to date and maintaining it as the standard handbook upon the subjects dealt with. A new part, dealing with Photogravure, has been added, which will tend to make the work still more useful.

My time being so much taken up with teaching and lecturing upon, and in the practice of, Photography and Photo-Mechanical Processes, I have not been able to devote as much attention to the revision as I should have wished.

In these days of go-a-headedness the progress of the arts and sciences is rapid, and new practices, apparatus, formulæ, etc., are continually being introduced to facilitate and cheapen processes; therefore, in the interval between the revision and the publication of this book, it is probable that there may be something introduced to supersede some of those recommended by me.

I shall always be pleased to consider any suggestion that may tend to the improvement of future editions of this work and to make it more valuable to the reader.

All methods and formulæ given herein have stood the test of successful use by my students (past and present) as well as by myself.

W. T. WILKINSON.

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LIST OF PLATES

STUDY OF THE HEAD.

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Photo-Mech. Processes.

INTRODUCTION.

THE Photo-Mechanical methods to be treated of in this manual will comprise the production of Letterpress blocks, in line and in tone, upon zinc and copper; Photo-Lithography, in line and in tone · Collotype; and Photogravure; with, incidentally, the application of the so-called three-colour methods of producing results in colour.

In pure line work, whether for Letterpress (Photo-Zincography) or for Photo-Lithographic printing, the methods are merely reproduction methods, either same scale, reduced, or enlarged, the originals being drawn in line, dot, or stipple; but in all the other methods we must create the grain, without which the smooth half-tones of a Photograph cannot be made available for Photo-Mechanical reproduction, each and every method requiring its own peculiar grain.

In tone blocks for Letterpress printing the grain is obtained by the interposition of a ruled cross-lined screen in front of the sensitive plate, the image being projected through that screen; these screens vary in degree of coarseness from 85 lines to 200 lines per inch, according to whether the block is required for fast printing upon coarse paper, or for slow printing upon fine paper.

For tone transfers for Lithographic printing these cross-lined screens do not give good results; but a screen called the Metzagraph, which gives an irregular grain very similar to a grained stone or the spray of an air brush, is capable of giving very fine litho prints. Perhaps the best method. however, is the grain obtained by drying a thin film of gelatine mixed with an alkaline bichromate, and a soluble ferri-cyanide, or a calcium salt. Such a film dried by heat after exposure to light gives a peculiar reticulated grain which is capable of transference to a smooth stone. and can be printed from quite easily.

Collotype is a Photo-Lithographic process, but the block is made by photographic means, and printed from in a similar manner to a Litho stone.

Photogravure is a method of preparing an intaglio on copper, the grain being obtained by dusting the plate with a resinous powder, or by the ruled screen method, or by both.

Each of these methods demands its own peculiar photographic negative, and it is almost entirely upon the quality of the negative that success depends.

The wet Collodion process is best, cheapest and easiest worked for negatives for blocks in line and in tone ; dry gelatine plates in the form of " process " or Photo-Mechanical plates are also used for the same purpose, and when worked intelligently, with a full knowledge of their capabilities and shortcomings, yield good results.

Collodion emulsion, especially as represented by Dr. Albert's Emulsion, leaves nothing to be desired, for three-colour work or for tone negatives, when the initial difficulties have been surmounted.

For Collotype and Photogravure, ordinary speed gelatine dry plates are as good as need be wished for, especially when pyrogallic acid is dispensed with as the developer in favour of the non-staining modern reducing agents, such as ortol, adurol, metol-quinone, &c.

In addition to using the most suitable Photographic method to secure negatives suitable for each particular process, it is essential that the apparatus and premises be suitable for copying drawings, photographs, &c. A solid well-built camera is required, extending at least 6 inches more than double the focal length of Lens ; the Lens used must be of the Rapid Rectilinear (R.R.), or, better still, of the Stigmatic or Anastigmatic type, the latter by preference, especially in the larger sizes, because of its flatter field.

The studio, work, and dark-rooms must be roomy and well ventilated and free from vibration, and above all, each room must be kept for its own work, and free from dust, dirt and rubbish.

Part I.

THE WET COLLODION PROCESS.

CHAPTER I.

THE WET COLLODION PROCESS.

To work this process we require clean glass plates of various sizes, iodised collodion, nitrate of silver bath, developing, fixng and intensifying solutions.

The Collodion.—This is a thin, viscous solution of gun-cotton (pyroxyline) dissolved in a mixture of ether and alcohol, to this being added various iodides and bromides. Collodion can be purchased, and when working on a small scale it will be better to do so. Messrs. Penrose & Co. issue a very good collodion made with Schering's Cellodin, and iodised to suit the requirements of the process worker. Mawson's collodion is still on the market, and is favoured by many good workers. Collodion is usually sold in two bottles—the larger one containing the plain collodion, the smaller one the iodising solution ; in this form the contents will keep indefinitely. For use, the two solutions must be mixed in the proportions of three parts plain collodion to one part iodiser ; after thus mixing the two, the collodion will be ready for use in about three days, and will keep in working order for two or three months.

When collodion is used in large quantities it will be found economical and advantageous to make it, but to do this successfully it is important to know something about the various ingredients.

The gun-cotton (pyroxyline) can be purchased, but only over the counter, the restrictions as to its carriage by rail or otherwise being many and irksome. To make it involves the setting apart of a small laboratory ; and as every batch of pyroxyline, however carefully made, will be different from

any other, and no batch perfect, constant experiment must be made of mixtures. Therefore, it is recommended to use as a substitute Schering's Cellodin, which is always reliable, and reduces the manufacture of collodion to a certainty, so far as the pyroxyline is concerned. As regards the ether and alcohol, nothing better than the methylated can be used. Methylated ether of the requisite specific gravity—viz., ·720 or ·725, can easily be obtained; but alcohol free from mineral oil is more difficult. This can be overcome by application to the Chief Surveyor, Excise Department, Inland Revenue Office, Somerset House. The form obtained must be carefully studied, as there are certain regulations to be observed as to keeping an account of how the spirit is used, and to permitting the Excise officers facilities, at all reasonable times, to inspect the stock of spirit. No less a quantity than 5 gallons can be obtained, but where photographic work is carried on 5 gallons of spirit will not be a great quantity.

Some authorities aver that methylated solvents cannot give good workable collodion, but in my own practice it has always worked well; and I am acquainted with one operator who for the last six years has used, on an average, 50 gallons per annum. The use of absolute alcohol and ether would render the price of collodion prohibitive, and would not result in the slightest advantage. Collodion should always be made up in bulk, because time is necessary for floating particles to settle. Filtering is of little use. Light has no action upon collodion, but heat has; therefore collodion must be kept in a cool place.

The iodising salts must be pure, and must be kept quite free from contamination. The iodides and bromides of ammonium, cadmium and zinc are the most generally useful, the ammonium salts conferring density, the other two keeping quality. Potassium salts should not be used, they being a prolific cause of pinholes in the negatives.

To make up 80 ounces of collodion, take 1 ounce of Schering's Cellodin, and put it into a clean dry Winchester quart bottle; pour in 45 ounces methylated ether (s.g. ·720), shake up vigorously for a few minutes, then let the

bottle stand for an hour or two to allow the ether to soak into the cellodin, next add 25 ounces of methylated alcohol (free from mineral naphtha), and shake up at intervals until the cellodin is all dissolved. In a smaller bottle dissolve :

Ammonium iodide	120 grains
Zinc iodide	60 grains
Ammonium bromide	60 grains
Methylated alcohol	10 ounces

Filter, and add to the collodion ; shake thoroughly, then put away to settle and ripen for about seven to ten days.

Another formula for the iodiser is :

Ammonium iodide	240 grains
Cadmium bromide	90 grains
Methylated alcohol	10 ounces

which will give a collodion suitable for tone or screen negatives.

For coating plates provide three 10- or 20-ounce corked bottles, and fill them with collodion ; use one of them during the day ; in the evening fill up with fresh collodion, and put it at the other end of the row, using No. 2 next day, and filling this up as before, and next day using No. 3, so that each bottle will have two days' interval between using. Never use the collodion to the bottom of the bottle, but put it away when three-quarters of the contents are used, so that none of the dregs get on the plate and cause spots. Never shake up a bottle of collodion, as, no matter how old the fluid is, or how often it has been decanted, a sediment will form, and should not be disturbed.

Nitrate of Silver Bath.—This is a very important solution, and requires care and cleanliness in its preparation and working. It is compounded by dissolving 6 ounces of nitrate of silver in 20 ounces of water, adding 10 grains of zinc iodide dissolved in 1 ounce of water, then 60 more ounces of water, shaking well and standing in sun or daylight until the solution is clear and bright ; filter through cotton wool, add $\frac{1}{2}$ dram of nitric acid, and the bath will be ready for use.

Filtration is best done through cotton wool, using a

glass funnel with a wide stem ; the glass chimneys used for the cheap form of paraffin lamps make very good filters. Clean the chimney thoroughly, tie a piece of clean muslin over the top, plug with a tuft of cotton wool, invert and put into a wide-mouthed bottle ; the result will be a filter always ready, and which will keep clean longer than the ordinary funnel.

One of the commonest causes of trouble with the silver bath is overworking it. Each ounce of collodion sensitised will remove at least six grains of silver nitrate ; in addition, there is a small percentage of unavoidable waste. All this must be replaced, or the quality of the negatives must suffer. To do this, add each evening a sufficient quantity of a solution of

Silver nitrate	240 grains
Water	1 ounce

to replace the silver taken away by the collodion used during the day. A time will, however, arrive when the quality of the negatives shows a great falling off, they being thin and dirty, and requiring a long exposure in the camera and an abnormal amount of alcohol in the developer to make it flow over the plate. This condition of affairs is caused by the fact that the by-products of the sensitising operation have become too powerful and require eliminating. In this case the best plan will be to take 40 ounces of the old bath and pour it *into* 120 ounces of water, then add sufficient of a saturated solution of carbonate of soda to make a piece of red litmus paper turn blue—*i.e.*, render the solution alkaline—then place the mixture in sun or daylight until a black deposit falls to the bottom of the bottle and the solution is bright and clear. Now filter carefully, add 10 ounces of nitrate of silver ; when dissolved add a dram of nitric acid ; again filter, and a new bath will be the result.

The remainder of the old bath should be evaporated to one-fourth its bulk and then added to 100 ounces of water, and allowed to stand till required.

In the above directions it must be noticed that the used silver solution is poured into the water, and this point is very important, as by doing this we get rid of a lot of

superfluous iodide, which, being soluble in a strong solution of nitrate of silver, would be kept in the solution should the water be added to the silver solution; but when the silver solution is added to the water, the water is in excess and the iodide is precipitated, and can be filtered out.

In evaporating the silver solution use either a porcelain evaporating basin or a good enamelled iron dish, with either a water or a sand bath underneath, as it is not a good plan to allow the naked flame of the stove to play upon the evaporating dish.

Such a long description of the care necessary to manage a bath may be apt to frighten a beginner and cause him to imagine that the whole process is difficult and tedious, but such is not the case if the precautions are duly observed. A bath carefully made and kept up to strength will last a year or two, so that it is well worth while being careful; and as forewarned is forearmed, nothing is lost by being clean and cautious. The signs whereby the bath indicates that its working capacity is at an end are, first, the inordinate amount of alcohol required in the developer to make it flow over the plate; secondly, the image is thin, flat and dirty, and refuses to intensify properly, the lines being dull instead of bright.

The Developing Solution.—This solution improves with age, so should be made up in bulk, and a stock always kept on hand. Make up two Winchester quarts (80 ounces each) at first, and when one bottle is exhausted refill it at once, so that it can ripen whilst the other one is being used.

The formula for a Winchester is

Sulphate of iron	4 ounces
Acetic acid	3 ounces
Water	80 ounces
Spirits of wine	from 1 to 5 ounces

This last ingredient has no chemical action, its function being to cause the developer to assimilate with the film and flow smoothly over it. When the silver bath is new, the spirit can be omitted altogether, but as soon as the developer refuses to flow evenly over the film, then spirit must be added at once, a small quantity at first, increasing the

amount as the bath gets older, until 5 ounces are required, then the bath requires renovating. Never add more spirit to the developer than is sufficient to ensure an even flow over the plate.

Fixing or Clearing Solution.—After the image is developed, and the film has been well washed under the tap, the lines of the image will look white on a reddish-grey ground, the white appearance of the lines being caused by bromo-iodide of silver that has not been discoloured or impressed by the light in the camera, and this must be removed before anything further can be done with the negative. This removal is called fixing (or clearing), and is effected by means of a solution of cyanide of potassium, or of hypo-sulphite of soda, both of which salts dissolve the bromo-iodide of silver. Cyanide of potassium is the best to use, but being a deadly poison and giving off unpleasant fumes, is objected to by many operators on that account; it however gives so much better colour to the negative, acts so rapidly, and is got rid of so easily that its objectionable features are condoned.

Hyposulphite of soda requires at least ten times the amount of washing to get rid of, and takes longer to clear the film. A plate cleared in cyanide solution can be washed and ready for intensification in two minutes, but one fixed in hyposulphite will take five minutes to clear, and at least ten minutes to wash.

Whichever of the two solutions is used, it should be kept in a dipping bath; one made of wood lined with thin sheet lead answers admirably, the dipper being of wood weighted with lead to overcome its buoyancy.

The formula for the solution of cyanide of potassium is

Cyanide of potassium	3 ounces
Water	80 ounces

The exact strength is of no great consequence so long as it is sufficiently strong to act quickly (say within half a minute); if too weak, it is apt to attack the image and make it thin. After being in use some time cyanide should be added overnight, and in the morning a stir with the dipper will distribute the freshly-dissolved salt.

Hyposulphite of soda should be kept as near saturation point as possible; it does not attack the image, and the plate may be left in for any reasonable length of time without danger.

Intensifying Solutions. — Wet collodion negatives always require intensification, more or less, and the operation is effected in different ways according to the process for which the negative is required.

If the negative is for collotype, or photogravure, it is intensified with the following :

Pyrogallic acid	30 grains
Citric acid	30 grains
Water	20 ounces

Just enough of this is taken to cover the plate, and 10 to 15 drops of a 20-grain solution of nitrate of silver are added; this mixture is poured off and on until the desired density is obtained, then wash, and fix with potass cyanide.

When the negative is from a subject in line, for photo-zinco or photo-litho, then a different treatment is required. First of all, after washing off the developer, the negative should be flooded with a solution of

No. 1.—Iodine	2 drams
Iodide of potassium	4 drams
Water	80 ounces

Pour sufficient of this to cover the plate into a glass measure, and add to it sufficient of a solution of cyanide of potassium to discharge the red colour of iodine solution ; flow this over the negative quickly, and at once well wash negative under the tap. Then it is ready for the first stage of intensification.

(The object of the iodine solution is to clear away all silver deposit from the lines.)

The negative is now bleached in

No. 2.—Ferricyanide of potassium	6 ounces
Nitrate of lead	4 ounces
Acetic acid	1 ounce
Water	80 ounces

The image is bleached in this solution right through ; it is then washed until white, then flooded with

No. 3.—Nitric acid	2 ounces
Water	80 ounces

Rinsed, and blackened with

No. 4.—Ammonium sulphide	1 ounce
Water	5 ounces

Washed, flooded with the acid solution, and again washed.

Another and more agreeable blackening solution is

Sodium sulphide	1 ounce
Water	5 ounces

using the acid solution before and after application.

For very delicate line work the following solution will give better results than the lead method :

Mercury bichloride	1 ounce
Ammonium chloride	1 ounce
Water	20 ounces

Dissolve, then add hydrochloric acid 1 dram. Bleach the negative in this, wash for, say, five minutes, then soak half a minute in

Hydrochloric acid	1 ounce
Water	20 ounces

Again wash five minutes, then blacken up with sodium sulphide as above.

The glass plates used for a wet collodion negative must be of the very best quality. Waste glass that has been used for dry gelatine plates cannot be utilised, as it is of too poor a quality for this purpose. A good flattened crown is the best for ordinary line negatives, and that should be procured, as it can be used over and over again. Glass plates for photographic use are cut to arbitrary sizes—viz. :

¼ plate	$4\frac{1}{4} \times 3\frac{1}{4}$
½ ,,	$6\frac{1}{2} \times 4\frac{1}{4}$
1/1 ,,	$8\frac{1}{2} \times 6\frac{1}{2}$

After these come 9 × 7, 10 × 8, 12 × 10, 15 × 12, 18 × 15, 23 × 18, &c.

Before a glass plate can be collodionised it must be made chemically clean, or the dirt will reduce the silver upon it

and ruin the negative. There are two methods of cleaning a glass plate, one by polishing with chamois leather, the other by coating with a thin film of albumen.

For the first method provide a good soft chamois leather, and wash it in cold water, to which has been added a little liquor ammonia, until the whole of the whiting is removed; give a final rinse in clean water and hang up to dry; when dry the leather will be soft and free from fluff, &c. Some pieces of linen rag will also be required, as well as a mixture of rouge in spirits of wine, and a flat board about 24 × 18 covered with a piece of smooth American leather, glazed side up; a plate laid upon this will not slip about during the operation of polishing.

Both sides of the plate must be thoroughly cleaned, and so must the edges, as one of the most prolific causes of derangement of the silver bath is organic matter introduced therein by imperfectly cleaned backs and edges of glass plates. One side of the glass plate, if gently rubbed with the thumb nail, will be found smoother than the other, and it is this side which is the most suitable for the support of the collodion film. Smear both sides with the rouge mixture and polish off with the linen rag, then with the leather; polish until, after breathing gently upon the plate, the film of moisture is quite even and quite free from streaks, not only in the centre but at the sides as well. The golden rule in polishing a glass plate is to polish the sides, and the centre will polish itself. When the smooth side is polished (the back being polished previously) raise the plate on edge and examine and clean each edge in succession; then the plate is ready for the dark room.

Polishing glass plates must not be done in the dark room, or it will be impossible to get a negative free from dust. Negatives made upon dirty glass have a bright silvery appearance behind, are dirty and stained, and will split off in drying.

When the plate is quite clean an edging of indiarubber dissolved in benzole (the edging to be about $\frac{1}{8}$ in. wide) is run all round the margin of the plate on the polished face; a small camel's hair brush tied to a small stick, the

end of stick and of brush being on a level, the stick then acts as a guard against the brush going too far from the edge. The indiarubber solution is used very thin and dries instantly. This edging is to prevent the film from slipping off the plate during the manipulations.

For line negatives the best method of cleaning the glass plates is the albumenising process, as then the film sticks much closer to the plate, and the operation of cleaning is not such a tedious one as that of polishing, nor is any dust raised. Polished plates cannot be done in advance, as they will not keep, but albumenised plates can be done in quantity and stored for use, keeping any length of time.

To prepare plates for albumenising first of all soak them in a dish containing nitric acid 5 ounces, water 80 ounces. Drop each plate in separately, and flat; if dropped in edgeways, they are liable to scratch those already in. Allow the acid to act for an hour or two, then take each plate out separately, and laying it on a clean board, with a piece of coarse wet rag or a small scrubbing brush scrub the plate thoroughly, both sides and the four edges, and as each plate is thus cleaned drop it into a dish of clean water. When all the batch have been thus cleaned and put into clean water, prepare a solution of white of one egg in 20 ounces of water. Beat up the egg thoroughly, add 20 drops of liquor ammonia, then pour into the water; filter this through cotton wool, and fill up a glass measure with the filtered mixture. Take a glass plate from the dish, rub it well on both sides with a clean wet rag, rinse under the tap, drain off the water, carefully examine both sides of the plate, and then flood the best side with the filtered albumen, throwing away what has been put on the plate; then put the plate on a rack to dry, and proceed to treat the whole of the batch in the same way. Be careful to put the sides that have been albumenised all facing one way, as there is nothing in the appearance of the film to show which is the right side. Stack the plates when dry on the shelf in dark-room, with the albumenised side next the wall. In pouring on the albumen from the glass measure, pour only

sufficient to cover the surface of plate, allowing as little as possible to get behind.

Glass plates that have been used, but not varnished, should be put into the acid water, which will speedily detach the old film. The plates are then scrubbed and dropped into the dish of clean water, and from thence are albumenised after a rinse under the tap. Negatives that are rejected before intensifying should be put into acid water at once, as allowing the film to dry upon the glass is not a good plan at all. Negatives that have been varnished are first immersed in a hot solution of washing soda, or in potash lye, the films being removed in these solutions. The plates are rubbed and rinsed, put into the acid water, again rubbed and rinsed, then into clean water, and from this albumenised.

The old films removed from the glass plates must not be thrown away, but should be collected by occasionally filtering the acid water and soda, or potash lye, through an old felt hat, one being kept for each. When the hat is full of films it should be burnt, and the ashes sent to the refiner, with used filtering plugs, blotting paper, &c., that have been used for the silver bath, and have received the drainings from the sensitive plates. All are worth saving.

CHAPTER II.

MAKING THE NEGATIVE.

THE chemicals being all prepared, the next proceeding will be to arrange them in convenient position in the dark-room, as it is usually called, but which, it may be explained, is merely a dark room so far as the admission of actinic or white light is concerned—*i.e.*, the room must be so illuminated as to allow of all manipulation being conducted in comfort, and with precision ; but the *colour* of the light must be such as will have no chemical effect upon the sensitive film of iodo-bromide of silver, formed in the film of collodion by immersion in the bath of nitrate of silver.

The amount of light, or area of dark-room window, cannot be too large, so long as the medium is of a safe yellow or orange colour. And if the room intended for a dark-room is provided with a window sash, cover the whole with three or four thicknesses of yellow or orange cloth, sold by photo dealers for the purpose. If a window has to be made, let it be 3 ft. × 2 ft., and glazed with a good yellow glass ; and then put in front of this one thickness of yellow cloth. Where the yellow or orange cloth cannot be procured, the yellow and orange printing paper used by letterpress printers will be a very good substitute ; but the outside sheet will require frequent renewal, as the light fades the colour somewhat. Where the window faces the south an extra blind to pull down, when the sun is shining, should be provided.

The yellow or orange window must be the only source whence light is admitted into the room. All chinks or

cracks admitting white light must be closed ; the doors also must fit close, else the plate will be fogged. A good method of testing a dark-room window is to procure a few gelatine *lantern* plates, and having covered up the dark room windows, fit one of these plates into a printing-frame behind an ordinary negative ; and when the cover is removed from the window, let the printing-frame lay in front of the window, about 2 ft. distant, for ten minutes. Then mix the developer, as directed upon the box containing the dry plates ; place a developing dish handy, and re-cover the window. Then remove the plate from the printing-frame, put it into the developing dish, pour in the mixed developer, cover up the dish, and allow to stand five minutes. Then remove the plate from the dish, wash under the tap, and immerse in fixing solution of hyposulphite of soda, and, when fixed, examine the result. Then, if the plate is quite clear, the window is all right ; but if there is the slightest trace of a picture upon it, the window is not safe, and will require another thickness of orange cloth or paper. This test is a very convenient one, and if all the operations (except the exposure of printing frame to the full power of the coloured window) be conducted in absolute darkness, it is a conclusive one; but it must be distinctly understood that a slow gelatine dry plate labelled "for the production of lantern slides" must be used, and not an ordinary rapid dry plate suitable for portrait or landscape work, as the light suitable for such a plate would be far too opaque for collodion working. Such a test will enable a beginner to commence his collodion work in confidence, and to know that if his plates show signs of fog, such fog arises from the bath, and not from his window.

The sink and water-tap should be in front of the window, the sink being of wood, lined with lead, and provided with a good outlet pipe. The dimensions of such a sink should not be less than 2 ft. × 18 ins., and 9 or 11 ins. deep, a shallow sink causing so much mess on the floor, from the water splashing over the sides. In the sink a small wooden stool is very handy, upon which the plate can be laid while being washed. The earthenware sinks now so much used

are very good indeed; but, being shallow, should be set low, and have a board in front flushed with lead to prevent the water splashing the operator and floor.

The benches on each side of sink are provided for the different solutions—that on the left carrying the intensifying dish; on the right, close to the sink, the iron developer, the developing cup, and, a little back from the sink, the dish, or dipping bath, containing the solution of cyanide of potassium. When dishes are used each one should have a light cardboard cover to keep out dust and splashes of other chemicals. At right angles from the bench on the right, and as far away from the sink as possible, the silver bath should be placed, and between this bath and the front of the room the dark slide should stand, the various carriers not in use being hung on a nail so as to be handy when wanted. A shelf about 3 ft. above this bench will hold the albumenised plates, face next the wall, and also the collodion bottles ready for use. Keep the dark-room free from anything else except just what appertains to negative making, and keep it clean, and half the troubles usually attendant upon working the wet process will be abolished. Provide one or two *clean* towels, and renew them with as much punctuality as is generally deemed necessary in your bedroom. The door of the dark-room must be quite light-tight, and be capable of being fastened on the inside, as nothing can be more annoying than having the door opened just when a plate is in your hands. All the care expended upon the fitting up of a dark-room properly will bear good fruit, in ease of working, and in certainty of results.

Everything being ready, we will now proceed to make a negative of a line drawing. First of all wash out the bath-holder and allow the water to drain away completely, then pour into it the silver solution, which has been previously filtered and is clear and bright—if at all muddy, and containing any floating particles, it will never produce clean negatives—put on the cover, then put the rest of the chemicals ready for use, wipe out the dark slide with a damp sponge, wiping the carriers also, and finally cut up

some clean blotting paper into inch squares, and lay a large sheet of blotting paper upon the bench close to the bath, together with a pad about 3 × 2 ins., to be used for wiping the back of the plate before insertion into the slide.

To begin, attach a pneumatic holder to the back of an albumenised plate, and, holding the plate in a horizontal position, dust with a broad camel's or badger hair brush (keep this brush always in one place, and never use it, or allow it to be used, for any other purpose than that of dusting clean glass plates). The pneumatic holder is in the left hand ; with the right hand get hold of a collodion bottle, remove the stopper with the little finger and palm of the left hand, then in the centre of plate (which is held as near level as is possible) pour as much collodion as is deemed necessary to cover the plate all over (putting on more in preference to less) ; then gently incline the plate the right-hand furthest corner; then as the collodion reaches the corner, incline the plate gently, so that the collodion flows towards the furthest left-hand corner, and then continue it to the left-hand near corner, and from thence to the remaining corner, under which the collodion bottle, from which the collodion was poured, is held, and the surplus collodion allowed to drain into it. Whilst the collodion is draining into the bottle, keep the plate as horizontal as possible—consistently, of course, with allowing the flow to go on unchecked—and keep up a gentle swaying motion of the plate, to prevent the collodion from running in lines. When the collodion ceases to run, raise the plate from the horizontal, and when the collodion ceases to drip, return the stopper to the bottle, and the bottle itself to the shelf ; hold the plate in a vertical position (diagonally) until the film at the lower corner has quite set, and is firm to the touch ; then, holding the plate by as little of the back surface as possible, detach the pneumatic holder from the back, and place the collodionised plate into the silver solution, previously closing the door of dark-room, as now, till the negative is fixed, no white light must reach it.

If the plate is held in the fingers for collodionising, the

two first fingers of the left hand must hold the edges of the plate, the corner being clipped by as small a portion of the thumb as is possible. If the tips of the fingers are placed under the plate, the warmth from them will cause the collodion to set over them too quickly, and cause a marked film. Plates larger than $8\frac{1}{2}$ by $6\frac{1}{2}$ cannot very well be held in the fingers, therefore a pneumatic holder is advisable.

If a dipping bath is used for the silver solution, remove the cover, raise the dipper till the ledge is about 1 inch from the top of bath holder, then place the plate upon the dipper, film side away from dipper; now lower the plate gently till the dipper touches the bottom of bath, cover up, and leave for three minutes.

If a flat dish is used, after removing the cover raise one end of dish with right hand, place one edge of the glass plate, which is held in the left hand, against the bottom of dish, then drop both dish and plate simultaneously, and the plate catching the wave of solution as it drops into it will cause the solution to flow over in an even wave. The dish must be dropped gently so as not to splash the solution. The position of the plate and dish just before dropping will be represented by the letter V on its side, so, ≻.

With either dipping bath, or flat dish, the plate must be immersed without any hesitation, or a sharp line will be caused.

At the expiration of the three minutes remove the cover from the bath and raise the plate (in a flat dish the plate must be fished out with a silver or ebonite hook), and it will be seen that the appearance of the film has undergone considerable change, the transparency having given way to a semi-opaque opalescent appearance, this change being due to conversion of the iodide and bromide that were in the collodion into iodo-bromide of silver by the nitrate of silver in the solution. This film is now sensitive to the light, and care must be taken that all white light is excluded from the dark-room. If the surface of the film shows any signs of a greasy appearance the plate must be gently raised and lowered a few times until this disappears

and the surface is quite smooth. Now lift entirely out, and let it drain until the solution no longer drips; then place one edge upon the blotting paper, and, holding the plate firmly by the top edge, wipe the back dry with the large pad of blotting paper. Next put the plate into the carrier of dark slide (the film being downwards and a small square of blotting paper having previously been put on each corner of carrier to take the final drippings), close the slide, and carry it outside for exposure of the plate in the camera. It is very important not to omit to drain the plate well, and also the small pieces of blotting paper in the corners of carrier, as by these precautions the waste silver is recovered from the blotting paper, and the dark slide is kept from being rotted by the silver solution. The film on the glass plate is very tender, and care must be taken in handling the plate so as to avoid damage. Be sure and do not touch the film in any way

The operation of focussing the camera is generally performed whilst the plate is in the silver bath, so that the exposure can be made quickly, and whilst the plate is in its best condition. Place the dark slide into its place in the camera, and having seen that the lens is covered, draw out the front shutter; then remove the cap from the lens gently, so as not to cause the camera to tremble, make the exposure, replace the cap on lens, close the shutter of dark slide, and return the slide to the dark-room, putting the slide in the place it was taken from. Now see that the developer is in the cup (a 4-ounce glass measure makes a good developing cup), and that all the other chemicals are ready for use; open the dark slide and attach a pneumatic holder to the back of the plate (not the holder used for collodionising, but another one, as each must be kept for its particular duty), and go to the sink, hold the plate in the left hand, in a horizontal position, take the developing cup in the right, and with a gentle sweep of the hand from left to right cover the plate with developer.* Do this gently, so as not to cause any of the solution to flow

* Wet collodion plates cannot be developed in a dish.

over the edges of the plate, but put on sufficient to cover the film completely, and in one wave, as if there is any hesitation in doing this the film will be marked. If the exposure has been about right, the image (hitherto quite invisible) will at once make its appearance, and as the plate is kept gently rocking to and fro it will gradually gain in brightness—the lines white, the whites a reddish grey. Continue the development until all detail is out, but do not allow the action to continue. When the lines show any inclination to lose their whiteness, at once turn on the tap, put the plate on the stool underneath the tap, and wash until the water runs evenly over the film. When properly washed, place the plate into the fixing or clearing solution (cyanide of potassium) and allow it to remain until the whole of the white appearance on the lines is gone—*i.e.*, until the iodo-bromide of silver, not acted upon by the light during the exposure of plate in the camera, is dissolved by the cyanide of potassium. When the creamy white of the lines has disappeared, the lines will be bright and the rest of negative a yellowish grey. The plate is removed from the cyanide bath and well washed under the tap. Now take the negative into the daylight and hold it up so that it can be looked through. Examine carefully: first of all see that the image is perfectly sharp all over, if not, at once reject it; also reject it if there are any spots or stains upon it. If the lines are dull or veiled and the negative transparent, it is bad. These veiled lines are caused by over exposure in the camera; unless the veil can be removed by gentle rubbing, then the bath requires the addition of a little nitric acid. If the lines are clear, but some of the finer details absent, and the negative generally thin and transparent, the exposure in the camera has been too short. Over exposure can be detected during development: when the image flashes out at once, and the lines veil over directly, it is a sign of such over exposure. Under exposure is indicated by the reluctant appearance of the image, and by the fact that, even with prolonged application of the developer, the detail in the dark portions will not come up.

Negatives rejected at this stage should be put into a dish of water at once, and not allowed to get dry, or the glass is injured and extra trouble involved.

When the negative is satisfactory it is well washed back and front, then drained, cleared with No. 1, washed, and at once immersed in intensifier No. 2 (nitrate of lead and ferricyanide of potassium). Here it speedily turns a light yellow, the time required for this varying with the solution. When quite new, one minute will be sufficiently long, but after being in use for a time, five or ten minutes will be required to obtain the necessary amount of bleaching. A little experience will, however, soon put an end to any uncertainty on this head. When properly bleached, the plate is washed until the yellow appearance gives way to a white; then the plate is held in the hand and flooded with a little of acid solution (nitric acid and water) No. 3, and again washed for half a minute; it is now flooded with solution No. 4, which will at once turn the film an intense black.* Look at the back, and as soon as the film shows black behind, wash the plate; then give a final dose of the acid solution, which will clear the lines; again wash, and put the negative away to dry. The acid solution must not be omitted, as its use prevents the formation of a brown stain on the lines, fatal to a good line negative. Plenty of washing is also absolutely necessary after bleaching, or the lines will be veiled beyond the power of the acid to remove. When the negative is semi-transparent, the cause may be either weak bath (generally accompanied by foggy lines or rotten lines), or the lead solution may be old and weak. In this case throw away and begin again.

A last word as to alleged difficulties in working the wet process. It must be remembered that the old wet process was mostly used for portrait and landscape work, in which the great *desiderati* were shortness of exposure and full range of half-tones; and, to secure these, the silver bath had to be worked as near neutrality as possible, and in

*This blackening the negative must not be done in the dark room, because the fumes would soon ruin the silver bath, but in a room specially set apart for the purpose.

that condition it was just on the verge of fog. And when, after a little working, this fog asserted itself, the addition of a little nitric acid and a rest soon restored the bath to a working condition. But the addition of the nitric acid, whilst not interfering very much with the quality of the negative, lengthened the exposure, and in time also affected the quality of the image; and it took all the skill and knowledge of the operator to keep the bath working at its highest sensitiveness, and, at the same time, keep up the quality of the negative. Now, in line negatives, we require neither extreme sensitiveness nor any delicate half-tones; consequently we can use a sufficiency of acid in the bath solution as will keep the bath in good order for a long time, so long as we do not allow the normal strength of the silver nitrate to fall too low. If a nitrate of silver bath be made and worked exactly as directed in these pages, and kept clean and free from any contamination with organic matter, and the other chemicals made and worked also as directed, the wet collodion process will be found quite as easy to work as any dry gelatine plate; and, as far as cost and quality are concerned, the dry plate cannot for a moment compete with it.

The method given above is for making negatives of subjects in line for photo-lithography and for photo-zincography, for each of which methods the same class of negative is requisite, in so far as the actual quality of negative and chemical manipulation are concerned. The only difference between a negative for photo-lithography and photo-zincography lies in the position of the image upon the film, and this difference will be illustrated and fully dealt with in the proper place.

CHAPTER III.

LINE NEGATIVES ON GELATINE DRY PLATES.

PROCESS or photo-mechanical plates are used for making negatives for photo-lithography and for printing upon metal for line and tone letterpress blocks. These plates may be developed with pyrogallol, hydrokinone, ortol, etc.; but hydrokinone gives the cleanest results.

The following formula will be found very good :

HYDROKINONE DEVELOPER.

No. 1.—Hydrokinone		150 grains
	Meta-bisulphate of potash	100 grains
	Potass bromide	30 grains
	Water	to 20 ounces
No. 2.—Caustic potash (pure)		250 grains
	Water	20 ounces

To be mixed in equal portions for development.

PYROGALLIC ACID DEVELOPER (STOCK SOLUTION).

Sulphite of soda	4 ounces
Citric acid	1 dram
Potass bromide	30 grains
Water	8 ounces

Dissolve, then pour into an ounce bottle of pyrogallic acid, and label.

STOCK SOLUTION PYROGALLIC ACID DEVELOPER.

No. 1.—Stock pyrogallic acid		2 ounces
	Water	18 ounces
No. 2.—Washing soda		3 ounces
	Water	20 ounces

For development, take equal parts of Nos. 1 and 2.

Give a full exposure, and develop for ten times the first appearance of image, this being the development factor

with the developers given. After taking the plate from the developer, rinse quickly under tap, then fix in clean hyposulphite of soda; when fixed, wash for a minute or two, then clear the lines with the clearing mixture of hyposulphite of soda and ferricyanide of potassium. This must be used cautiously, else the dense parts will be attacked as well as the lines, the function of the clearing mixture being to clear away from the lines the deposit of silver granules formed by the developer owing to the action of the white light reflected from the black lines; these reflections are only feeble, and are easily cleared away. After the clearing bath has done its work, wash the plate thoroughly: then, if necessary, intensify.

For fixing, use clean, strong hypo., say 6 ounces of hyposulphite of soda to 20 ounces of water.

CLEARING SOLUTION.

No. 1.—Hyposulphite of soda	3 ounces
Water	20 ounces
No. 2.—Ferricyanide of potass	2 ounces
Water	20 ounces

For use, take 1 dram of each and 2 ounces of water.

INTENSIFIERS.

No. 1.—Mercury bichloride	1 ounce
Ammonium chloride	1 ounce
Hydrochloric acid	10 minims
Water	20 ounces
No. 2.—Liquor ammonia	1 ounce
Water	5 ounces

No. 1 can be used over and over again until exhausted, but No. 2 must be fresh with each batch.

Gelatine dry plates, when used for line negatives, should always be backed, either by the manufacturer or just before use, a good backing compound being made as follows:

Strong gum mucilage	1 ounce
Caramel	1 ounce
Lamp black	1 ounce

Mix in a mortar to form a thick paste, and apply to the back of plate with a brush; or a piece of black paper may be soaked in water and squeegeed to plate.

To intensify a negative it is first of all bleached in the solution of mercury bichloride and ammonium chloride, washed for five minutes, then soaked for one minute in

Alum	1 ounce
Hydrochloric acid	1 dram
Water	20 ounces

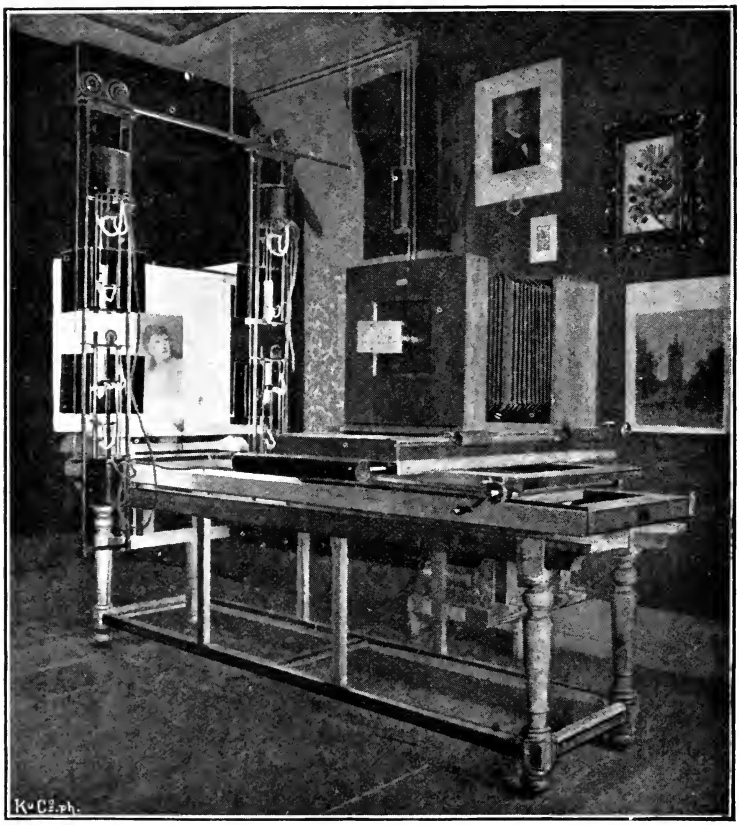
Again wash for five minutes ; now immerse in the mixture of water and ammonia, in which the film will immediately blacken all over ; again wash, and put the negative away to dry.

Another method of blackening is :

Caustic potass	½ ounce
Formalin	1 dram
Water	20 ounces

Sodium or ammonium sulphide may also be used, but are not recommended, as there is always a risk of stained lines with either of them. If the use of either ammonia or caustic potash, after bleaching with mercury and washing, does not give sufficient density, the plate has been under-exposed, and it is only wasting time trying to make a good negative out of it.

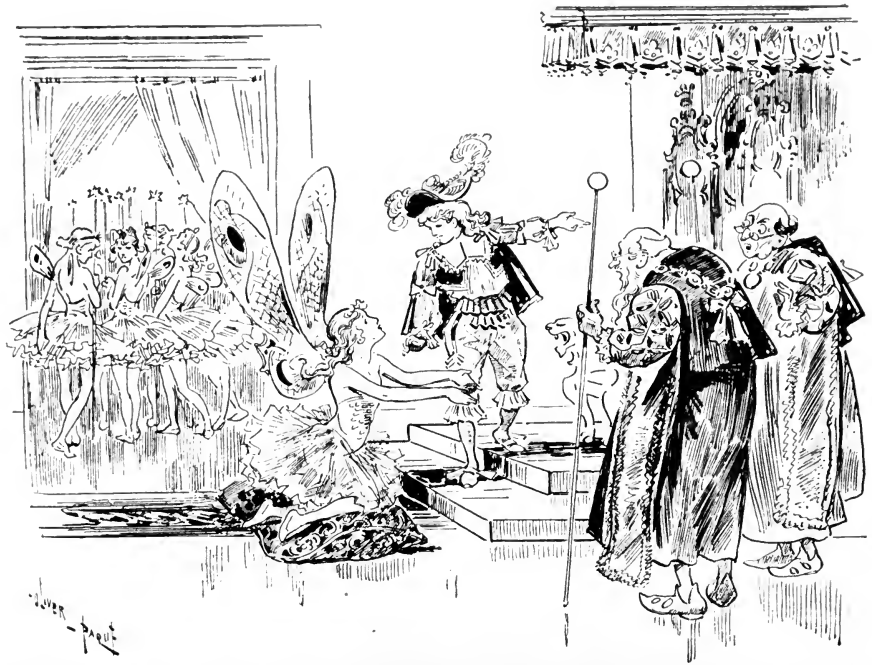
After the negative is washed it is generally a good plan to clean it by rubbing it all over with a wet plug of cotton-wool, and after another rinse putting it away to dry. If required in a hurry, blot off surface water with clean cambric or linen (not cotton), then immerse for three or four minutes in methylated spirit, drain, and put into a warm draught to dry.



An Electrical Installation, with Camera for Process Work.

Part II.

LETTERPRESS BLOCKS IN LINE.



LINE ETCHING.

From "The Wingless Fairy."

CHAPTER I.

LINE BLOCKS.

In order to produce a Letterpress block (commonly called a Zinco) on zinc, a photograph of the original drawing (which must be in line, dot or stipple) must be put upon the metal of such a nature as can by some means be converted into an acid-resister, or is in itself so constituted as to form the acid resist. Such a photograph can be put upon the metal in many ways, and either by direct printing or by transfer. By direct printing the metal itself is sensitised, and the image impressed by the action of light, the sensitiser being bichromate albumen, fish glue, or bitumen. By the transfer method photo-litho transfers (see Part IV) are used, and this method offers points of economy not to be despised, because by using such transfers a number can be put down at once upon one sheet of metal, so economising in metal and in time. Both this and the direct methods are essential where the original (N.B.—The word original, as here used, is meant to include copies made from engravings. lithographs, &c., as well as from drawings made expressly for reproduction) is larger or smaller than the desired block, but the drawing may be made upon stone, or zinc, or aluminium, or upon transfer paper, in which case the image resist is transferred to the metal, and thus prepared for etching. This alternative is mentioned here for the sake of completeness ; but we are immediately concerned principally with the photographic methods of producing the resist image, so will at once direct attention to the apparatus and materials needed for that method.

First of all, it is necessary to have good and suitable apparatus for the production of the photographic negative ;

LINE BLOCK WITH TINT TRANSFERRED.

and it is impossible to attach too much importance to the fact that, whether for occasional or for regular use, with good appliances the work can be done with a smoothness and precision not possible with makeshifts. Do not try to combine the practice of outdoor work with that of copying, it being almost impossible to build a camera quite suitable for both purposes. For line work the camera used must be strong and rigid, and capable of a bellows extension of a little over twice the focal length of lens necessary to cover the largest size plate the camera will take, this focal length of lens being equal to the diagonal

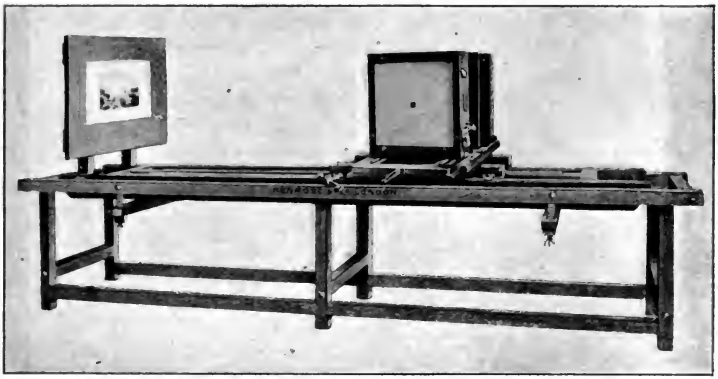


FIG. 1.—CAMERA AND COPYING EASEL UPON STAND.

of plate; thus, for a plate 15 ins. by 12 ins. the lens should have a focal length of 19 or 20 ins., and the camera bellows allow of an extension of 42 ins. The camera must be supported upon a perfectly firm stand, running on wheels set in rails at right angles to the copying easel. In those cases where the photographic room is liable to vibration from machinery or from the street traffic, the camera and copying easel must be supported on a swinging stand, of which there are many forms in the market. (Fig. 1.)

The Lens must be of either the rapid rectilinear type, or, better still, the stigmatic, such as those made by Dallmeyer, Cooke's process. Ross homocentric lenses are amongst the best class of instruments for the purpose.

For direct printing upon metal we require what is called a reversed negative—that is, the position of the image must be correct when viewed with the film next the eyes, in contradistinction to an ordinary negative, which requires to have the glass side of negative next the eyes, to see it in its correct position. These reversed negatives can be obtained by exposing the sensitive film in the dark slide,

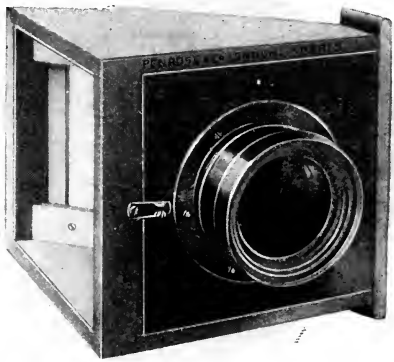


FIG. 2.—THE MIRROR.

with the glass support facing the lens, by stripping and turning the film of negative after it is otherwise finished, or by using either a mirror or a prism in front of, or behind, the lens, and placing the camera sideways to the copy. The method of exposing through the glass is troublesome and uncertain. Stripping the film is tedious and also uncertain, the use of either a mirror or a prism being always the best.

The Mirror.—This (Fig. 2) is a piece of plate glass,

one side of which is ground perfectly plain, and this side is coated with a film of pure silver; this film being subsequently polished, will reflect the image from the lens without the slightest loss of light. It will be useless trying to work with an ordinary piece of plate-glass, except in very rare cases, as unless the surface of glass carrying the reflecting film of silver be absolutely flat, the lines of the image will be distorted. The attempt to use an ordinary mirror, with the back surface as the reflector, will result in the production of a double image. The size of the mirror must be sufficient to take the whole cone of rays from the lens, and, as it is mounted diagonally at right angles, must be longer than it is high; for a lens the diameter of which is 4 inches, a mirror 7 by 4 will be ample. The cost of a mirror, silvered ready for use, is usually about one shilling per square inch; and as with care the silver surface will last for one or two years, and can then be re-silvered at a cost of sixpence per square inch, it is not a costly piece of apparatus.

Mirror Box.—The base of the box should be made square, so that the lens can be turned downwards—a very useful position when copying out of a book, &c. The mirror must be very carefully managed to prevent tarnish and scratches; it should be taken out of the box when not in actual use, and after being carefully warmed in front of a fire, should be wrapped in a piece of fine silk velvet, also warmed, and put away in an air-tight tin case. If the surface gets tarnished, it can be easily repolished with a pad of fine dry chamois skin and dry rouge.

The Prism.—A good prism (Fig. 3) is rather more costly than a mirror; but, on the other hand, it will not require re-silvering, nor will it require such constant care to keep in order. The illustration will give a good idea of the prism. As regards use—mirror or prism—there is no difference, except that when the silver on the mirror is tarnished a longer exposure is necessary than with a prism.

The Kahlbaum mirror supplies at a less cost a very good substitute for the prism, and, like the mirror, can be used

for different lenses, which, as a rule, a prism cannot be, on account of the solid mounting requisite.

For copying drawings, &c., by daylight, a skylight or studio will be required; but this need not be an elaborate affair, so long as the copy-board or easel is well and evenly illuminated; whether the light comes from above or from

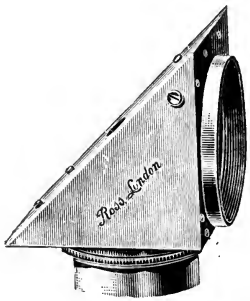


FIG. 3.—THE PRISM.

the side is quite immaterial. When electric light is used, and wet collodion process, two arc lamps will be requisite, each of from 15 to 50 ampères, at 100 volts; but for process dry plates from six to twelve incandescent gas burners, arranged on movable stands, will give good results.

The easel or copy-board must be perfectly parallel with the camera, both vertically and horizontally; it should be made of soft wood, so that the requisite pins for keeping the drawings, &c., flat can take a firm hold without hurting the fingers.

CHAPTER II.

APPARATUS FOR PRINTING UPON ZINC.

THE articles necessary for printing upon the zinc plates are :—Polished sheets of zinc, gauge 17 ; fine whiting ; fine emery cloth, No, oo ; a cork rubber, as used by carpenters for holding glass paper when preparing woodwork for polishing ; a board covered with American cloth, glazed side out ; a wooden dish, about 24 inches by 18 inches by 6 inches deep, lined with pitch, and upon rockers ; 1 lb. of fine cotton wool ; an atmospheric gas or a paraffin stove ; an inking slab of litho stone, or marble, about 15 × 12, or a sheet of zinc screwed at the corners upon a board ; retransfer ink, stone-to-stone, or litho printing ink ; a bottle of turpentine, the cork of which is nicked, so that the turpentine can be sprinkled out ; an ordinary type printers' roller, about 8 or 10 inches long, cast without a seam ; a whirler ; a well-made printing frame, box pattern, the bars of which are fitted with wooden screws, to give pressure, and the front a piece of ½-inch plate glass ; a small glass funnel ; two 5-oz. glass bottles ; two 10-oz. ditto ; bichromate of ammonia or bichromate of potass.

Zinc Plates.—Zinc plates, suitable for photo engraving, must be of the best rolled metal. They are sold in sheets, or in cut sizes, planished, and polished ready for use. Various thicknesses can be obtained, but 17 to 15 gauge (B.W.G.) are quite thick enough for all practical purposes. It will be best to purchase it in large sheets, say 24 × 18, and cut it up as required, with either a circular saw, a hand saw, or a guillotine.

The Polishing Board.—This is a very useful piece of apparatus, and is simply a flat board 1 inch thick, covered on one side with a piece of smooth American cloth, glazed side out. A plate laid upon this board can be polished without slipping about, as it does on the bench. The cost of this board is not much, but its value is great.

Re-transfer Ink.—This is the ordinary re-transfer ink—stone to stone—as used in everyday-work by lithographic transferers, or ordinary photo-litho transfer ink. Good stiff litho-printing ink is, perhaps, better than either of these, as where it is used the image is sufficiently strong to enable the operation of rolling-up to be dispensed with, the plate being ready for the etcher directly it leaves the printer on the metal.

The Roller.—This must have a good smooth surface, and be cast in a cylindrical mould without a seam; it may be on a litho stock, with projecting handles at each end; but one on a frame with a centre handle, as used by typographic printers, will be best. This roller should not be less than 8 inches long and 3 inches in diameter; it should be of the best procurable composition, and neither too hard nor too soft, especially the last, as if at all soft, it will drag and not ink up the zinc properly. Climate has a great deal to do with these rollers, as they are made of gelatine and glycerine, or sugar, or treacle, and a roller suitable for the climate of England will not do for a hot climate; but this is always provided for by the manufacturer, if told for what place it is required.

The Whirler.—In order to get an even coating of albumen upon the zinc plate, it is essential that the plate be spun round with some velocity, so as to throw off the superfluous albumen by centrifugal force; various forms of whirler are now on the market, a favourite one being here illustrated (Fig. 4).

The Sensitiser.—Either the bichromate of ammonia or the bichromate of potash can be used to render the albumen sensitive to light. The ammonia salt is the most sensitive, and also has the advantage of giving a film that is not so liable to spontaneous insolubility in damp weather; the

film also keeps longer. The potash salt is much cheaper and more readily obtainable, and, with the addition of a little liquor ammonia, has all the advantages of the ammonia salt, except in the matter of exposure. For summer weather the potash salt will meet all requirements, in winter and in damp weather the ammonia salt is best.

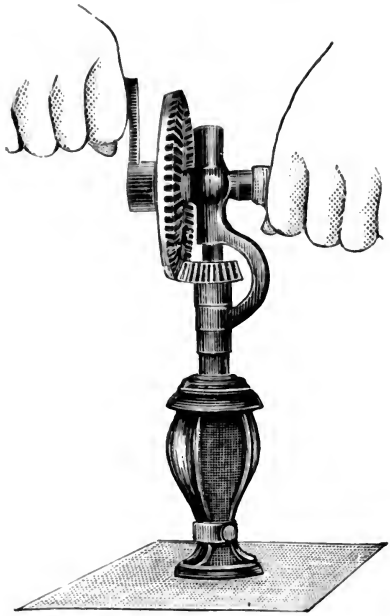


FIG. 4.—THE WHIRLER.

The Printing Frame.—If the surfaces of the negative and of the zinc plate were absolutely flat, the mere laying of the one upon the other would serve to get the desired contact between the two; but as this perfect flatness is not possible in practice, means must be adopted to get the contact during exposure to light. For this reason the printing frame must be so made that screw pressure from

behind can be applied, and so press the two surfaces into contact; but as the front of the frame must be transparent it consequently must be of glass. This glass should be of sufficient substance to withstand the pressure requisite to bring the two surfaces in contact, and this pressure, given, as it is, by means of screws, is so great that the thicker the glass the less chance of breakage. Glass less than ½ inch thick, even for small frames (or below 12 × 10), should never be bought, as, although glass 1 inch thick is costly, still it is far cheaper in the end; it is also important that the glass front of the frame should not fit at all tight.

CHAPTER III.

PRINTING ON ZINC IN ALBUMEN.

In order to get an image upon the zinc, it is coated with a solution of white of egg and bichromate; this film is dried over a flame. The plate is then put into a printing frame in contact with the negative, and exposed to light; the lines in the negative being transparent, the light renders the bichromated albumen insoluble in cold water. When the exposure is finished, the plate is covered with ink; the lines hold the ink and form the image, the whites washing away, because having been protected from the action of light by the dark portions of negative, the albumen underneath is still soluble in cold water.

A film of bichromated albumen when dry is very sensitive to the action of light, therefore the preparation of the plate must be done in a yellow light (gaslight will do), the window being covered with one thickness of yellow fabric or of paper.

The zinc plate is first polished with a wet rag dipped in fine whiting, or rotten-stone. then washed and placed on whirler; give the plate another rinse under the tap, then whirl, reverse the whirler, holding the plate level, and coat with

White of one egg	
Water	10 ounces
Saturated solution bichromate of ammonia	1 ounce*

Have a lot of small pieces of glass in the bottle, put in

* Or 45 grains of potassium bichromate, or 60 grains ammonia bichromate.

the white of egg and shake up well, add the water, then the bichromate of ammonia.

Two ounces of saturated solution of bichromate of potash may be used instead of bichromate of ammonia, but in this case 20 drops of *liquor ammoniæ* will also be required; a solution of bichromated albumen will keep in good condition for months.

The solution of bichromated albumen must be well filtered before use, and cotton wool is the best filtrant. Take a plug of cotton wool (surgical wool must be used, *not* cotton wadding), wet it, then throw it with some force into the neck of a glass funnel, and proceed to filter the albumen into a glass measure, but before coating the zinc plate remove all air bubbles from the surface. Coat the zinc plate on the whirler with the filtered albumen, and whirl; dry the film by holding the zinc plate (film up) over the gas stove, moving the plate about until the film is dry.

When the film is dry it should be slightly shiny and quite even; if there are any wavy marks upon it there is too much bichromate in proportion to the white of egg. To remedy this, make up another egg, and only add half the quantity of bichromate to it; then add this to the other, and the result will be a good film. When a film does not dry properly on the zinc plate wash it off with water, and the plate is ready for re-coating. The albumen must be well filtered, or the film will be dirty and useless. Coat the plate in a room illuminated with yellow light, or by gaslight—as this has no effect upon the sensitive film. If done in daylight, the image will not develop properly.

The front glass of the printing frame must be thoroughly clean, the back of the negative also. Place the film of albumen on the zinc plate in contact with the film of negative, hold them tight so that they do not slip, then slide the negative along the front glass of the frame, and let the two plates drop into middle of the frame, put in the back, and screw up tight, applying the pressure carefully and evenly, then put the frame into the light for exposure. The time of exposure of a bichromated albumen film will

vary with the strength of the light available. In bright summer weather, in direct sunlight, three minutes will be sufficient, but when the sun is lower in the heavens, five or six minutes will be required. In diffused daylight from five to ten times more is necessary, and when the negative is perfect, with clear lines and opaque whites, great latitude is permissible; but if the whites are thin, or lines veiled, then the exposure must be hit to a nicety. (N.B.—With a good negative, 75 per cent. of all trouble is avoided, but with bad and indifferent negatives there is any amount of trouble.)

When the plate is exposed, the frame is brought into the workroom, and the plate removed. It is then rolled up with an ordinary typographic printing roller, charged with good lithographic printing ink, thinned with turpentine. The ink used must be good litho printing ink, quite stiff. Ink ready for the machine or press cannot be used. A little of this ink is put on the inking slab, and sprinkled with turpentine, the two are then worked up thoroughly until of the consistency of thin cream, using a stiff palette knife; the roller is now passed through this ink, and the exposed plate, being laid face up on a clean sheet of paper, is rolled up, the roller being rolled to and fro until the turpentine has evaporated, leaving the film dry and thin. A good sign as to when the rolling is sufficient is when the plate adheres slightly to the roller. The film of ink upon the plate must not be too thick; if at all black, it must be sprinkled with turpentine and rolled again until dry.

Lithographic printing ink gives a cleaner and crisper image than the old method of using transfer ink, but the ink must be stiff and thinned with turpentine, not with varnish.

When the plate is rolled up it is immersed in a dish of clean cold water, and rubbed gently under the water with a pad of cotton wool, when the ink on the whites will wash away, leaving the image in black on the metal. Remove it from the water, and clean out the ink from the finer lines, give a rinse under the tap, and put away to dry.

If the lines wash away during the development, the exposure has been too short; if the ink refuses to leave the whites, and no picture can be developed, the exposure has been too long.

Plates that have been used require re-polishing with the whiting, or rotten-stone, before re-coating with albumen.

CHAPTER IV.

TRANSFERRING TO ZINC.

To make a relief block from a drawing made upon transfer paper, or from a transfer from stone, or from copper, the image is transferred to the zinc plate in a lithographic press.

As a rule, original drawings in line, or in chalk (on grained paper), are never transferred direct to zinc, but are first transferred to stone, and, when etched and made ready, re-transfers are made for transfer to zinc. This is done in order to guard against accident in etching the zinc plate, as, if the original is transferred to the zinc plate, and is spoilt in etching, then it must be re-drawn, entailing expense and delay; but when the original is put down on stone first, then, if an accident happens, another transfer can be made quickly.

Transferring to stone, as well as transferring to zinc, requires an intimate acquaintance with lithography, and can only be attempted successfully by an expert lithographer.

The zinc plate, to which it is desired to transfer the image, should be well polished, and grained in a bath of

Water	80 ounces
Alum	1 dram
Nitric acid	1 dram

The plate is immersed in this, and the dish rocked until the surface is a grey matt instead of being polished. Wash the plate well under the tap, removing the scum on the plate with cotton wool, then dip into hot water, and the plate will quickly dry after removal and be ready for transferring. When the image is transferred it should be rubbed (or rolled) up with lithographic printing ink, dried up, again dried, and it is ready for etching.

CHAPTER V.

APPARATUS, &c., FOR LINE ETCHING.

FOR the process of etching a zinc block we require :

1. One or two good black lithographic rollers.
2. Two pairs roller handles.
3. A glazed lithographic roller.
4. Strong palette knife ; ditto push knife.
5. Two inking slabs.
6. Soft etching ink.
7. Hard etching ink.
8. Thin lithographic varnish.
9. Solution of gum arabic.
10. A hot plate.
11. An etching trough on a stand worked by power.
12. A pair of bellows.
13. Fine resin powder.
14. Fine asphaltum powder, or dragon's-blood.
15. Turpentine.
16. Nitric acid.
17. A flat brush.
18. A solution of shellac in spirits of wine.
19. Two or three sponges, and a supply of clean rags and chamois leather.
20. A strong scrubbing brush, a strong solution of lye, paraffin oil, and sawdust.
21. Tools for cutting up the zinc, trimming and mounting the block.
22. Baywood for mounting the zinc plate on.

The Roller.—For rolling up, or reinforcing the ink on the block after each etch, a good lithographic roller is required ; but two such rollers would be better, keeping one for the first rolling up when lithographic ink is used, and one for the soft etching ink, which is much greasier and more difficult to scrape off.

The roller used is a leather lithographic roller for black ink, usually called a nap roller ; the leather is stretched on a stock covered with felt, the flesh side of the leather being outside. When such a roller is bought new it requires a certain course of preparation before it can be brought into use. First of all it is warmed in front of a big fire and smeared all over with lard, rubbed in with the hand until the leather will absorb no more. When the lard has set the roller is scraped with a palette knife. To scrape a leather roller properly, before rubbing in the lard the leather is stroked with the hand, and when the set of the nap has been found—just as the nap of velvet sets —the handle towards which the nap sets is cut, and the roller is always scraped towards that cut, the handle with the cut upon it being always next the body, while the other handle rests against the inking slab on the bench, and the pressure of the body holds the roller tight. To scrape a roller the palette knife is held horizontally across the roller, both hands grasping the blade; the edge of the knife is then dragged from the bottom to the top, which action brings with it a length of lard (or ink), and the knife is wiped on the left side of the portion scraped, which clears the knife and shifts the roller round a little. When the knife is clogged with fat (or ink), it is wiped on waste paper. The roller being scraped, smear it with a little strong lithographic varnish and roll up on the slab. This varnish is very stiff, and requires strength to get the roller over it at first, but patience will conquer. Continue rolling up with this varnish (replenishing at intervals), at occasional spells, for two or three days, in order to clear out the dressing from the leather, and also to give stamina to the nap. Next scrape the roller, then roll up in soft etching ink thinned with thin litho varnish. Let the ink be quite thin at first, and gradually increase its consistency until quite stiff. This operation will extend over three or four days, at the end of which again scrape, and the roller will be usable, though it will not work at its best for some little time.

A good second-hand roller should be purchased, but

do not get one that is half worn out. To take a new roller and put it at once into ink is to utterly spoil it, and it will never work properly. A lithographic roller well broken in and ready for use is worth ten shillings more than when quite new and untouched.

The Glazed Roller.—A glazed roller can be made from a new roller, such as are sold for colour work, the grain of the leather being outside, instead of in as for a nap roller. Such a roller is first rolled up with lithographic printing ink until the leather has absorbed ink equally all over, and is then rolled up with a mixture of gold size and red lead, mixed to a stiff, smooth paste ; this, when evenly rolled up, is allowed to get quite dry and hard, after which the surface is smoothed and polished with fine glass-paper till it is level and smooth. If the first application of the gold size and red lead be not sufficient to obtain a smooth, hard skin, another must be made. This roller must not be scraped, but may be cleansed with turpentine and a rag.

Soft Etching Ink.—Lithographic ink will give a good resist to the acid used in etching, but when it is required to form a cover for the sides of the lines after etching it will not run, no matter how much it may be heated ; therefore, in order to protect the sides of the etched lines, an ink must be provided which, when heated, will run.

The following formula gives a good etching ink :—In an iron saucepan melt 6 ounces of Russian tallow, and as soon as the crackling noise stops add 5 ounces of yellow beeswax; when this is melted, add 2 ounces of asphaltum, stir until this is dissolved, then add 1 lb. of lithographic printing ink, adding a little at a time, and stirring until each portion added is melted ; finally add 1 lb. of thin litho varnish, mix thoroughly, and pour out into tins or jars. When cold this is ready for use.

Hard Etching Ink.—This is a hard varnish rather than an ink, and is used to protect the tops of the lines whilst the steps caused by the different deep etchings are removed by the acid bath.

The ink is composed of

Beeswax	½ ounce
Resin	1½ ounces
Litho printing ink	2 ounces
Shoemaker's wax	2 ounces

Melt together in a saucepan, stirring well until thoroughly mixed; then pour into a jar or tin. and when cold it is ready for use.

Thin Lithographic Varnish.—The medium used by lithographers for thinning their inks is called varnish, but it is not a varnish as understood by photographers, carriage painters, &c., as it is really a burnt oil, the burning being resorted to in order to get rid of the fat. There are various degrees of consistency of these varnishes, viz., strong, medium, and thin; but we are only concerned with the last (except a little strong, which is like birdlime, for occasional use in preparing a new roller), which is used to thin the ink—principally the soft etching ink—to working consistency. This varnish is to be purchased from any dealer in printing materials. Good varnish keeps any length of time, improving with age; bad varnish skins over and becomes greasy.

Solution of Gum Arabic.—A solution of gum arabic is essential to keep the ink from attaching itself to the bare zinc, and to confine itself to the lines only. It is made by dissolving good gum arabic in water, thereby making a thick mucilage. A good way of making it is to half fill a jar with gum, fill up with cold water, and put the jar in a warm corner, stirring at intervals until the solution is thick enough; strain into a clean jar, add a few drops of carbolic acid, and it is ready for use.

The Hot Plate.—For commercial work this is a necessity, and consists of a thick iron plate, with top planed level, mounted upon an iron framework, and heated by atmospheric burners fixed underneath; a plate 18 × 15 inches, ½ inch thick, and about 2 feet high, makes a good hot plate, the heater being composed of three perforated pipes, each fitted with an atmospheric orifice at base, all three being attached to the one gas supply. For occasional

work a small iron tripod, upon which the plate is laid, and heated with an atmospheric blowpipe arrangement, is very handy; or the plate may be held at one corner by a pair of pincers, and heated over a gas-stove. The hot plate arrangement is the most satisfactory one.

The Etching Trough.—The etching trough (or box, as it is generally called) must be much larger than the largest plate etched therein. To etch a zinc plate 12 × 10 inches, the etching trough should be at least 24 × 18 inches, and 9 inches deep; the reason for this being that unless the

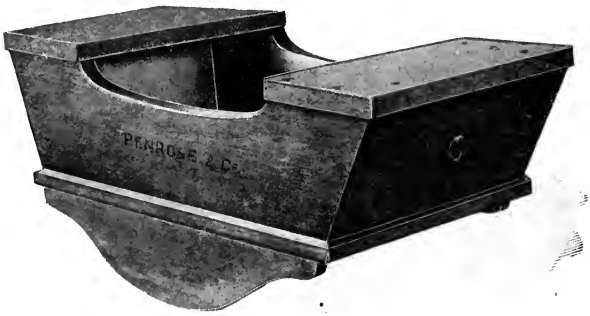


FIG. 5.—ETCHING TROUGH.

etching fluid has plenty of room to wash over the plate each time, the operation of etching is very much prolonged, and proceeds unequally. This box, or trough, may be mounted upon rockers, but the best plan is to fit it in a frame, suspended by pivots in centre of box, longways, and attach to it a crank worked from one end by a wheel, much in the same way that small wheel pumps are worked. Where power is available, this crank can be connected with driving shaft, then the etching requires very little attention.

The etching trough should be made of good seasoned inch deal, the bottom tongued and grooved into the sides, the tongues being well smeared with paint before screwing up. It must be lined inside with stout canvas and pitch, well ironed down, the coat of pitch being at least $\frac{1}{4}$ inch

thick, the outside of box being covered with two or three coats of good black varnish. For commercial work the box should measure 30 × 20 × 9 inches at least.

The Bellows.—An ordinary pair of domestic bellows are very handy with which to dry the plate when wet with water or gum.

Inking Slab.—These may be of slate, marble, litho stones, or of thin zinc, screwed to a wooden slab. Two are recommended, but the worker can manage with one.

Shellac Varnish.—In order to protect the back of the plate during the etching operation, a good coat of varnish is required. Black varnish is sometimes recommended, but it does not dry so rapidly as is desirable, neither does it withstand the repeated heatings, but requires to be renewed each time after such heating ; and if this is not done at the right moment (*i.e.*, before gumming up), the varnish is of no use. Shellac varnish dries quickly, resists the acid perfectly, and is easily made by half filling a wide-mouthed bottle with orange shellac, filling up with methylated spirits, stirring up the mixture occasionally. The varnish will be thick enough in a few hours, and if methylated spirit be added from time to time until the shellac is exhausted, it will always be ready. Keep the bottle well corked, and have a brush fitted in a hole in the centre of the cork.

Tools for Cutting Up.—Zinc plates may be cut up with a hand saw, and smoothed with a file ; but for commercial purposes, a circular saw or a guillotine (Fig. 6) will be necessary for economy and precision. A planing block and plane are also required in order to turn out the blocks square and smooth. The holes in the zinc plate, through which the pins are driven to hold it upon the wooden block, may be drilled with a hand drill, or punched with a fine sharp punch. The pins used generally have conical heads, the top being flat, and are known as stereotypers' pins, though they are also used by shoemakers. Ordinary flat-headed pins stand up too much to be useful. The wood used to mount the blocks upon is baywood, about $\frac{7}{8}$ inch thick, this giving, as a rule, a block just under type high, which is far better than being

over. The printer can easily bed up a block, but seldom has the means of reducing the thickness.

FIG. 6.—GUILLOTINE FOR CUTTING UP ZINC PLATES.

The rest of the articles require no special comment, but all are necessary, and cannot be dispensed with.

CHAPTER VI.

ETCHING IN LINE BY THE ROLLING UP METHOD.

In Chapters III. and IV. two methods are given of obtaining the image upon the metal, and as these plates are left at the end of each chapter in an identical condition, no different treatment is required on the part of either of them during the process of etching. The ink upon the plates, as left at the end of Chapters III. and IV., is not sufficient in quantity to resist the action of the acid that will be used in etching ; therefore the first step to be taken will be to reinforce that ink and obtain a capable resist.

First of all dust the image with dragon's-blood powder, rubbing it well into the ink, then carefully wipe off the surplus powder from the metal, next place on the hot-plate until the dragon's-blood is melted, then cool ; just before the plate is cool, cover the back and margin in front with a thin coat of shellac varnish, this being done when the metal is warm the shellac dries at once.

Prepare a bath of

Water	1 quart
Nitric acid	1 ounce

Put in the plate and rock for one minute, remove, wash under the tap, and rub off the scum with a piece of cotton wool, then dab dry with a damp leather. At this stage the image should be carefully examined, and if any of the lines require retouching now is the time to do it, then cover with a thin coating of gum arabic, let this dry, and proceed to roll up with the etching ink.

Clean the slab and scrape the leather roller, then take some soft etching ink out of the tin with the palette knife, and smear it along the roller. Next roll up all over the slab until the ink is evenly distributed over the roller and the slab as well. This operation takes some little time, and must be done properly. Then, having washed the dried-on gum from the plate, lay it, face up, on the bench, and proceed to roll up with the charged roller. Keep the plate well covered with moisture so as to prevent the ink taking on the whites, and continue the rolling until the image has taken as much ink as it possibly can. If the roller is too heavily charged, or the ink is too thin, the lines will get ragged, so care must be taken to guard against this. The water on the plate will make the surface of the roller glazed; when this happens, the roller must be passed over the slab until the surface is clear again. Roll up the plate slowly, and with moderate pressure—heavy pressure and slow motion feeds the work; light pressure and quick motion takes off ink. Roll deliberately, and at frequent intervals re-wet the plate, and re-roll the roller over the slab. When the image has taken as much ink as possible, dust it over with some finely-powdered asphaltum, brushing the powder well into the ink with a flat brush (of hog-hair).

We are now ready for the first etch, which will take from three to five minutes.

The etching trough must have sufficient water in it to cover the bottom about $\frac{1}{4}$ inch deep; to this is added sufficient nitric acid to make the water taste tart. The plate is now immersed, and the trough set rocking until the lines are standing up from the whites of zinc, about the thickness of a visiting card. The acid must be sufficiently strong to cause small gas bubbles to form upon the surface of the zinc, unless the solution be kept in motion, but not so strong as to cause these bubbles to form in spite of the rocking. As the etching progresses the acid will get weaker, and more must be added, but this is seldom required unless a large surface of zinc is etched in a small trough; then constant attention is required, and the work does not

progress very satisfactorily. During the progress of etching a little of the solution poured on the plate from a height will clear the scum away from the metal; then, directly the rocking covers the plate again, if the zinc darkens, the acid is present in sufficient strength; but if the metal still retains the light colour, then the acid is not strong enough, and more must be added. Commercial nitric acid varies so much in strength that it is not possible to give exact quantities, unless the etcher possesses an hydrometer and knows how to use it; and even then the operation of testing would be far too complicated to be at all useful, wasting more time than would be necessary to get the plate etched. The best guide will be careful attention and subsequent application of the knowledge gained. Keep the acid sufficiently strong to give a vigorous bite, but not so strong as to cause the gas bubbles to form in spite of the rocking given to the etching trough. In this lies the whole secret of etching a zinc plate. If the acid is too weak the process is not only slow, but there is far more danger of undercutting the fine lines; therefore, the work will progress more satisfactorily all round when the acid is kept up to its full strength, but the plate must be very carefully watched, as upon this, the first etch, the whole quality of the block depends.

The depth of the first etch should be about the thickness of a visiting card; but here judgment must be used. A block of a diagram with very broad whites and a few lines will require a little different treatment to a block in which there are few whites, or a block for a newspaper. Each class of subject must be treated in such a manner as to get the best results from each. Feeling the edge of the plate at the margin will give a correct idea as to the progress made, and constant examination of the plate will show if there is any danger of undercutting the finer lines. When it is judged that the etching has proceeded far enough, the plate is removed, washed under the tap, rubbed gently with a soft sponge to remove the oxide, and *dabbed* dry with a soft cloth. Do not rub, or the ink may smear, and cause trouble afterwards. Examine the plate closely, first, to

see if the work is intact. If any of the lines are seriously interfered with, the whole plate is spoilt ; if some are only slightly touched they may, perhaps, be strengthened with a brush charged with hard etching ink, thinned with turpentine till it will flow easily from the brush. The lines being intact, it must next be determined whether the depth is quite sufficient ; if not, the plate must be returned to the etching trough for a little longer. The first etch is the most important stage of the whole process, and unless this is sufficiently deep, and is managed without encroaching on any of the lines, the plate will not be good. First of all use the acid of sufficient strength to bite the plate well, but not too strong to cause gas bubbles to form and stick to the metal, in spite of the rocking motion of the tray ; have sufficient depth of liquid—but no more—to just cover the surface of plate ; and, above all, do not attempt to etch in a small dish, or to put too many plates in the tray at once.

The first etch being satisfactory, the plate is put upon the hot plate, a piece of clean brown paper being placed underneath. As the heat of the plate will cause the zinc to curl upwards, provide a couple of bradawls and force the corners down alternately, so that the plate may be heated evenly all over. The effect of the hot plate will be to cause the etching ink to melt and run down the sides of the lines. The colouring matter in the ink runs but slightly, the greasy ingredients being those most easily melted ; therefore, to the unpractised eye, the full effect cannot be at once seen. When sufficiently run the plate is taken from the hot plate and allowed to cool, and is next smeared with the acid gum, which will at once show exactly how far the grease in the soft etching ink has run down. The metal where bare assumes a bluish tint, but where the grease has run down the acid cannot get at the metal, and it remains white. Careful observation of this will show exactly how far the sides of the lines have been protected. Allow the coating of gum to dry, then moisten, and roll up with the leather roller charged with soft etching ink ; roll the plate first one way and then another—keeping it well

moistened during the operation—until, by examination, it can be seen that the sides of the etched lines are quite covered. In the case of very close lines the image will be quite obliterated, the grease having spread entire from line to base. This is all right, as such close work is quite sufficiently deep by the first etch. When properly inked up all over, dust with powdered resin, rubbing this well into the ink with the brush. Wash off the superfluous resin, and, after strengthening the acid in the etching trough, put in the plate and proceed with the second etch.

The image is now, or should be, perfectly protected from the action of the acid, therefore this etch does not require the same close attention that the first etch did. Keep the acid well up to strength, and the etching trough in constant motion, until the depth is double that given in the first etch. The time occupied by the second etch will rarely exceed twenty minutes if the acid is kept well up to maximum strength—*i.e.*, just short of causing gas bubbles too obstinate to be dispersed by the rocking motion of the tray —and the etching tray kept in constant motion. When the second etch is completed the plate is washed under the tap, rubbed with the sponge to remove the oxide, dabbed dry with a soft cloth, then put upon the hot plate until the ink is again melted and run down the sides of the lines. The plate is next cooled, and smeared over with gum, fanned dry. then the gum moistened ; after which the plate is again rolled up with the leather roller charged with soft etching ink, the ink this time being used a little thinner and with more on the roller. Keep the plate moist and use plenty of pressure upon the roller, so that the ink can reach the lowest depths ; dust over with powdered asphalt, carefully examine the varnish at back of plate, and if it has been disturbed or abraided apply some fresh. Let this dry, then proceed with the last etch. This time the acid can be used stronger, because all the work is now, or ought to be, thoroughly well protected, so that the etching can proceed as rapidly as may be desired, and the acid kept to a good biting strength.

Where a lot of work is done, after the second etch, a

routing machine is used, with which the broader whites are removed to any desired depth, after which the plate is ready for clean etching, to get rid of the shoulder left by the cutting tool of router.

When the third etch has been taken as deep as it is desired the finished plate to be, the plate is washed, and then the whole of the ink is cleaned off, first with paraffin, then with lye. A handful of sawdust is good for finally cleaning the plate.

Now the plate is deep enough and cleaned off; still it is not quite ready for printing from, because the successive steps, or ledges, left by each etch, would be apt to catch the printing rollers, and would eventually give a dirty print. To obviate this, the plate requires clean etching, for which purpose the glazed roller is used to coat the tops of the lines with the hard etching ink. This glazed roller should be kept coated with the ink ready for use, as the ink cannot be used wet, and it takes a little time to get dry.

To charge a glazed roller, wipe it quite dry with a rag and a little turpentine, take a piece of hard etching ink out of the tin, put it on the inking slab, sprinkle with turpentine, and with the palette knife mix the two thoroughly until the ink is about the consistency of treacle. Roll the glazed roller in this until it has upon it a thin even coating, continue the rolling until the ink is almost dry, then put away the roller till wanted.

For clean etching, put the cleaned plate on the hot plate (with a large piece of clean paper under it), and as soon as it is warm, pass the glazed roller (charged with ink, as above) over it; the ink on the roller will adhere to the tops of the lines, and will give a resist to acid. Take the plate off the hot plate, and place on the bench; continue the rolling up here until the plate shows a tendency to stick to the roller; then take the plate, and carefully examine all the lines, in case any minute spot may have escaped being touched by the ink on the roller. If such is the case, it must be touched up with a brush charged with hard etching ink thinned down with turpentine. This must be carefully attended to, or some of the lines may be honey-

combed, and the effect spoilt. After the plate is rolled up and examined, the back must be coated with varnish, also the margin. When this is dry, it is ready for the acid. Empty the solution out of the etching tray, put in some more water, add sufficient acid to taste sharp, then immerse the plate, and start the etching trough rocking, and continue it until the edges of the steps are smoothed down. A good plan of ascertaining the biting power of the solution is to make a slight scratch in the varnish on the margin, and every now and again to feel this with the finger-nail to see if the depth is increasing or not. Great care must be taken that the picture is not injured during this etching, constant watching to prevent this being necessary.

Allow about three minutes' immersion in this bath, then withdraw, wash, remove the ink with paraffin, followed by lye, scrubbing with a strong brush. Wipe it dry, then examine, and if not sufficiently smooth, repeat the operation of warming, inking up, and re-etching.

The acid solution used for this clean etching can be kept and used for first etching of fresh plates, but acid used for first etching is not suitable for clean etching.

Mounting the Plate.—The margin must be cut away before mounting upon the wood block. This can best be done by means of a circular saw, but in the absence of this a small hand saw or fret saw may be used. After sawing away the margin, the rough edges are removed with a file, holes are pierced with a drill in the edges and in the centres of the broadest whites ; then take a piece of bay wood, about $\frac{7}{8}$ inch thick, and with stereotypers' pins nail the trimmed zinc down to the wood. When this is done, with a chisel and mallet cut out the broad whites right through to the wood; and if the whites are very broad, scoop out the wood also. By cutting the metal after nailing on the wood, it is driven into the wood, and prevented from curling up. Next cut the block out, and with a shooting plane square the sides, and then, if the picture does not come close up to the edge, bevel the edges downwards.

CHAPTER VII.

ETCHING IN LINE BY THE DRAGON'S BLOOD PROCESS.

THE print being on the metal, and the metal quite dry, warm it slightly, and touch up any lines that may be defective, using transfer ink diluted with turpentine; and with the same ink paint over any wide whites up to within $\frac{1}{4}$ inch of the lines. Now warm the plate and coat the back and margins with thin shellac varnish; whilst warm place in the dusting box, and with a soft brush rub over with powdered dragon's blood, forcing the powder well into the ink; then wipe the plate quite free from the surplus powder with swansdown; now warm the plate until the powder melts and is incorporated with the ink, and so forms a resist. The plate is now ready for the first etch in

Nitric acid	2 ounces
Water	40 ounces

making up sufficient to just cover the plate in etching tray. The strength of acid as given is only approximate, acid and zinc being both variable; the best guide being to note that if acid is in excess gas bubbles form on the metal, in which case more water must be added. If the acid is used too weak, then the action is slow, and the lines are apt to get rotten. Rock the tray during the etching, and brush over the plate with a soft brush.

The first etch must only give a decided grip to the finger-nail on the edge of margin, or in a scratch in margin. When this depth is reached, wash the plate under the tap, then dab dry with a damp chamois leather; warm upon

hot plate sufficiently to make the lines tacky, but not sufficient to melt the powder—this can be tested by putting a little powder upon the plate : if it adheres to the metal the plate is too hot, but if it can be blown away the lines may be brushed over with the powder.

The acid in etching will have left the sides of lines bare, and this must be covered up, or the lines would in a short time be so undercut as to be spoilt ; therefore the powder must be brushed into the undercut. To do this, warm the plate until the lines just glisten ; then in the dusting-box, with the brush, rub the powder well into the lines from top to bottom, repeating the operation until the lines have lost their stickiness. Now carefully remove the surplus powder from the whites, either with a suitable brush or with swansdown. Again warm until powder is melted ; return to dusting-box ; brush with the powder, this time

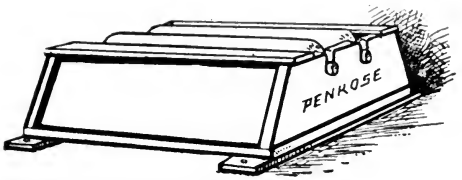


FIG. 7.—COOLING APPARATUS.

from one side to the other ; and then clear off the surplus powder. Again melt the powder ; return to dusting-box, brush on the powder (this time from bottom to top), and repeat the operations. After melting the powder return to dusting-box ; apply the powder the reverse way of the second dusting ; remove surplus powder. Again warm till powder melts.

The lines now ought to be completely protected, and should be carefully examined, any gaps being filled in with varnish, or another warming up and dusting.

A cooling apparatus, consisting of one or two felt-covered rollers revolving in water, over which the plate is passed (face up), will be found very useful for bringing down the temperature of metal quickly and evenly. (Fig. 7.)

The plate having been dusted four times, and examined carefully for defective dusting, the shellac resist on back having been attended to where required, it is ready for the second etch, for which purpose add, say, another ounce of nitric acid to the etching bath, and give about five minutes; but, of course, the true test will be to watch the progress of the acid's action at the bottom of the line, and when this shows that the etch has proceeded as far as is safe, the operations of warming up and powdering four times are again repeated, the etching bath again strengthened, the plate again etched. After three etches, the plate ought to be ready for the router, but of this the operator must judge.

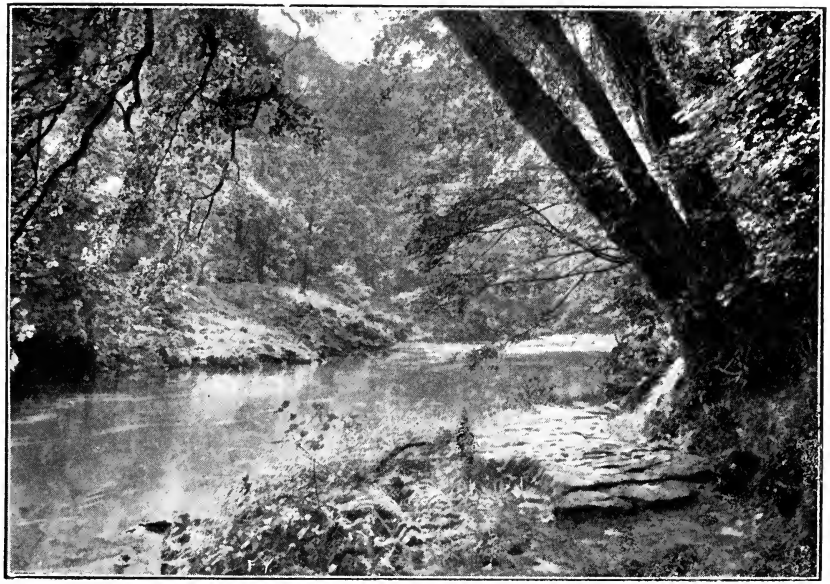
When the plate is deemed to be sufficiently etched, clean off all the resist with potash lye, dab dry and warm, rout out the open whites, again warm, and roll up with the glazed roller charged with hard etching ink; examine lines carefully to ensure that they are all covered, coat the back of plate with thin shellac varnish, make up a fresh etching solution of

Nitric acid	2 ounces
Water	40 ounces

and proceed to etch until the roughness left by router and the shoulders caused by the powder are all smoothed down. It will be advisable with some blocks to give two or three such final etchings, cleaning off the ink and re-inking each time; but here, again, judgment must be used.

Part III.

LETTERPRESS BLOCKS IN HALF TONE.



RIVER SCENE IN BOLTON WOODS.

[Made with a Levy Screen.]

CHAPTER I.

THE SCREEN.

The Screen.—Screens can be obtained of any desired size and of a number of grades of ruling (from 55 lines to 200 lines to the inch); but for ordinary practical use nothing coarser than 85 lines or finer than 175 are required. A screen ruled with 85 lines is suitable for printing from on a fast rotary newspaper machine, 100 lines for fast flat printing on coarse paper, 120 to 125 for average work, 133 for finer printing, and 150 to 175 for art printing. In a large establishment it will be necessary to keep all the above grades, but for a small user choice may be made of either 125 or 133. Screens, especially when of a large size, are very expensive, and consequently ought to be taken great care of. They must be kept perfectly clean, and to do this the screens should be polished with "papier Joseph" and a little spirits of wine. The slightest scratch on the surface is sufficient to ruin a screen, so great care must be taken in the cleaning operation. To avoid scratching, when not in use, the screens should be kept wrapped up in velvet, new washleather, a silk handkerchief, or in a grooved box.

The best screens are the original ruled screens, copies not being much cheaper. Those ruled with equal lines and spaces are the most in favour, other rulings being only useful for special work. Up to recently the Levy screen was the only one procurable; but now there are several other makers, Johnson, of Leicester, having devoted a great deal of time and experiment to the manufacture, has

SCREEN 85.

SCREEN 100.

SCREEN 125.

COARSE : 85 and 100 lines.—For use in newspapers and rough printing generally.
MEDIUM : 120, 125 and 133 lines.—For illustrated weekly papers, some magazines, and ordinary commercial work.
FINE : 150 lines.—For best class magazines, book and catalogue illustrations.
VERY FINE : 175 and 200 lines.—For machinery and similar subjects where detail is of paramount importance. N.B.—Only with best paper and ink can good results be obtained from these screens.

[Blocks lent by the Arc Engraving Co., Ltd., 4 & 6, Farringdon Avenue, E.C.]

SCREEN 133.

SCREEN 150.

SCREEN 175.

SCREEN 200.

[Blocks lent by the Arc Engraving Co., Ltd., 4 & 6, Farringdon Avenue, E.C.]

produced as good a screen as can be wished for. The Metzagraph screen of Mr. Wheeler, and the irregular grain of Haas, do not seem to be adaptable to letterpress blocks, but are useful for lithographic purposes. The three, four, and five-line screens introduced by Levy do not seem to have made any headway, perhaps on account of their extra cost. Chessboard screens and irregular lined screens also are not used, in spite of the outcry against the mechanical regularity of a process block.

Screen Gear.—The screen, being a rather bulky affair, necessitates the use of various methods for fixing it in position in front of the sensitive plate. The best method is that illustrated in Fig. 8, which shows the screen gear

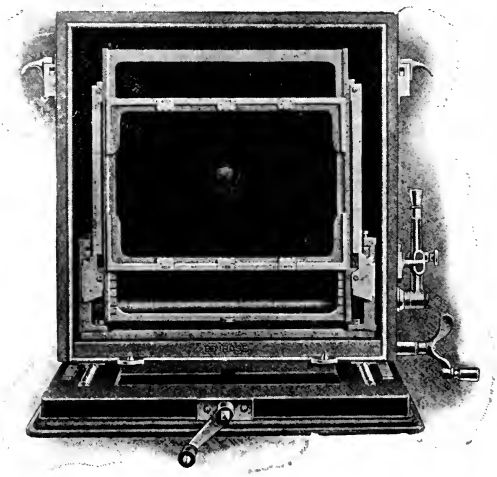


FIG. 8.—SCREEN ADJUSTMENT GEAR.

fitted in the body of the camera, and is so arranged that it allows of the withdrawal or advancement of the screen, rendered necessary by the shutter of dark slide. The handle at side, as shown, is used to move the screen after

the operation of focussing has been done, and again to replace the screen close to the sensitive plate after the insertion of dark slide and withdrawal of shutter, the proper position for the screen being shown by an indicator outside.

A camera fitted as above is as near perfection as can be desired ; the necessary adjustments are speedily made, and the screen being fixed in the camera does not incur any risk of being broken or scratched as does a screen carried

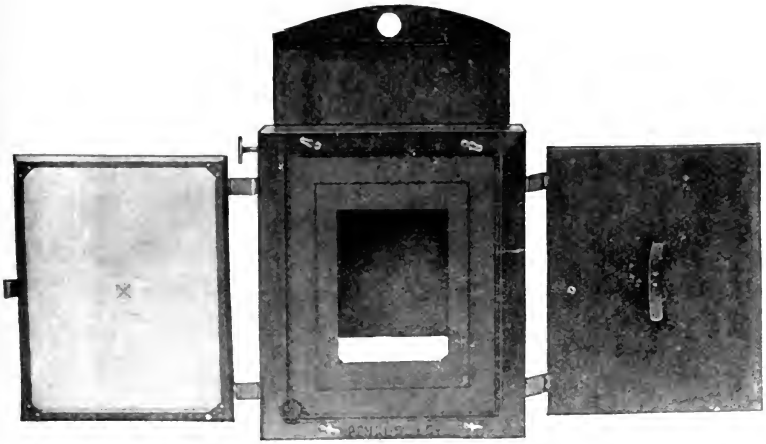


FIG. 9.—NEW PATENT DARK SLIDE.

in a dark slide. In fact, where a screen over 12 × 10 is used no other method than this ought to be tolerated.

When a dark slide is used there can be nothing better recommended than the new patent slide just introduced by Messrs. Penrose & Co. (Fig. 9). The focussing is done in the slide, a ground glass frame being provided to fit in the same plane as the sensitive plate, and the centre of the ground glass has a clear 1-inch square for focussing with a microscope, thus enabling the adjustment of the screen and the focussing of the dot being done accurately and

easily (see Fig. 9). A dark slide of this description can be adapted to fit any camera otherwise suitable for copying.

Whilst it is an undoubted convenience and advantage to have an adjustable screen gear, still it is not an absolute necessity; therefore, if the student is in possession of a dark slide with sufficient space in front of the sensitive plate to take a screen, and hold it rigid and parallel, good work can be done with it; but a little more care will be required, and very much more exactitude will be necessary to choose the correct size of diaphragm.

Using the Screen.—The uninitiated operator might easily be excused for thinking that, given a screen, it only required putting in its place and making an exposure of the subjects through it; but such is far from being the case. In the first place, a knowledge as to the proper distance of screen from sensitive plate is requisite, and also the exact size of stop that will suit the particular subject in hand; and it is this last which takes the beginner the longest to quite understand. If the subject to be copied is of first-class quality, with true gradations from deep shadow to high light, a diaphragm, or stop, that bears the No. F. 16, will, with careful adjustment of the screen gear, give a perfect grained negative; but if the subject be either flat, or, on the other hand, a hard black and white one, then that stop will no longer be of service. In the first case it will be too small; in the other too large. The above statement will suggest the question, What do we want? Well, here is the reply: From the subject to be copied we require to make a negative which, when held up to the light for examination by the naked eye, should give the impression of being a soft, delicate, and harmonious one; and, upon examining the whites with a strong magnifier, it is found that, instead of being of even density, they are broken up with a sort of chess-board pattern, with transparent holes at regular distances in between. In the half-tone the holes or dots are apart, and the shadows are peppered all over with opaque dots. Such a negative can only be obtained by the stop aperture and screen distance being adjusted to exactly suit the subject being reproduced.

Messrs. Penrose & Co. have introduced a patented set of diaphragms, with which is issued a small book giving directions for use. This system has been well tried, and is commended and used by many experienced operators,

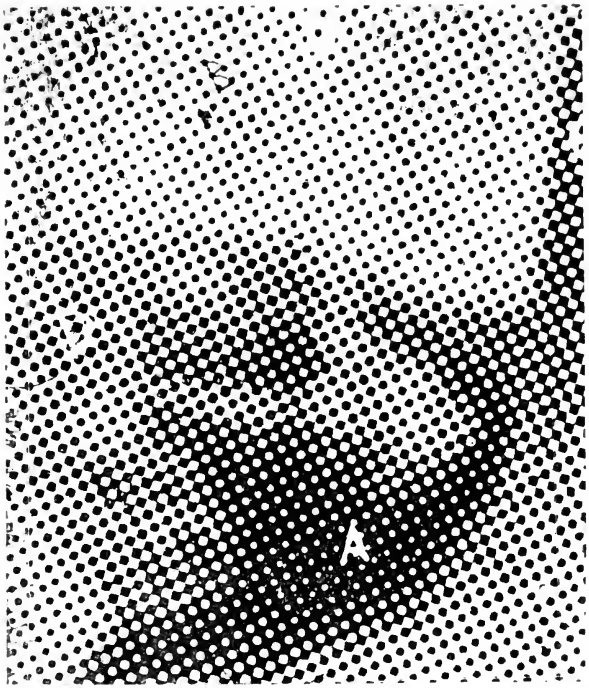


FIG. 10.—ENLARGEMENT OF A HALF TONE NEGATIVE SHOWING: A, THE TRANSPARENT DOTS IN WHITES; B, SOLID DOTS IN SHADOWS.

who have not been able to find fault with it. With a set of these diaphragms, cut to fit the lens, it is only necessary to use the Tables of Screen Distances, in book of instructions, for the purpose of determining correct size of stop.

The best method of working is to measure the extension of camera from the diaphragm to plate, look for the largest size stop permissible for this extension in the screen tables, insert the square stop of this size in the lens, and examine image on screen with the microscope over the transparent aperture in focussing screen; for the correct size of the dots racking the screen to and fro till the dots appear as they ought to in the negative. The exposure is made with this stop for the high lights; then insert a small stop,

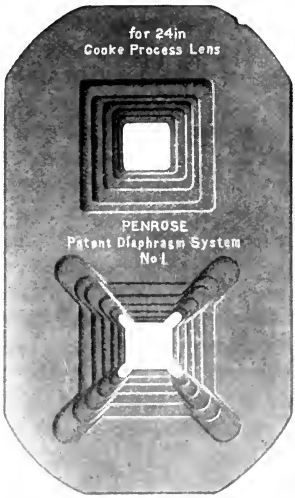


FIG. 11.—PENROSE'S PATENT DIAPHRAGMS.

e.g., F. 45, and with that in expose for the shadow dots, giving a final exposure to a sheet of white paper, using a stop about F. 128.

Some operators get shadow dots in their negatives by using a very small stop as above, and moving a sheet of white cardboard in front of the print which is being copied. This is sometimes very useful when copying hard black and white subjects, but is not recommended for general

work, as it is apt to give flat results, that require too much fine etching.

Lighting the Studio.—This ought to be done by electric arc lamps, daylight being too uncertain a quantity.

Nowadays, when the installation of an electric light plant suitable for a photo-process establishment has been brought to a high state of perfection, instead of wasting space describing such installations, the reader is referred to a dealer's catalogue, where not only the plant all through will be described, but also the prices and improvements up to date.

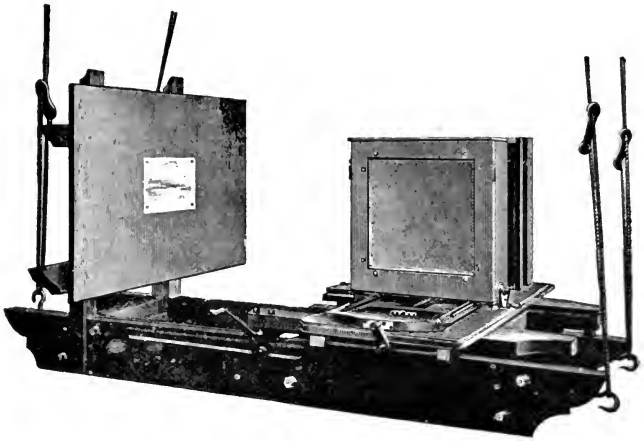


FIG. 12.—SWING BASE AND COPY BOARD.

For shaky studios the newest appliance is here illustrated, and it is one of the most compact and useful pieces of apparatus that can be imagined; another pattern, to stand on the floor, being illustrated in Fig. 1.

The Lens.—For the production of grained negatives it is necessary that the lens should be capable of giving a sharp image of the original, with a moderately large stop, because if the lens does not define properly without a smaller stop than that necessary for obtaining the requisite dot,

then it will be impossible to get good results. The lenses most suitable are the new Cooke process lenses; Dallmeyer's stigmatic or any of the anastigmat lenses of the best makers. Good work can also be done with the old rectilinear form of lens.

Negative Process.—The question as to which process is best for the production of grained negatives resolves itself into this—if you are an expert wet collodion man, and have suitable facilities for its practice, then by all means use it, as under those conditions it is undoubtedly the best and cheapest; if you are not up in wet collodion, but are intimate with the collodio-bromide process, then use that; but if you are a gelatine worker, pure and simple, then stick to gelatine dry plates. And here a word on the quiet. For grained negatives do not use the ordinary photo-mechanical or process plate, but use either the new half-tone process plate, or else a good ordinary gelatine dry plate; but the greatest care must be taken to have the window or developing lantern perfectly safe, this being the only thing likely to cause failure unless carefully attended to.

Prism *v.* **Mirror.**—On the score of economy and convenience a prism is better than a mirror. So long as the mirror is in good condition, then one is as good as the other, but a mirror requires constant attention,* and in time will cost more than a prism, hence it is an economy to purchase the last-named at first. Both prisms and mirrors require careful adjustment to fit the lenses intended to be used with them, and this adjustment must be done by someone who understands thoroughly what he is about—more especially when a screen is used—as the slightest variation will give the impression that the lens is bad, and entirely prevent good work being done.

* The Kahlbaum mirror does not require any re-silvering, being like the prism in this respect; only breakage or careless handling will spoil it.

CHAPTER II.

MAKING A GRAINED NEGATIVE.

Making the Grained Negative.—First of all, the wet collodion method will be described. The process itself is written in full in Chapters I. and II., Part I., of this book, and to those chapters nothing further need be said than this:—Patent plate glass should be used for these negatives, and the plates should be very carefully albumenised, in order to guard against dirty glass and other troubles, such as the film slipping or blistering, &c.

We will now suppose that a negative is ready for development, as it is here that the real making of the negative commences. Flood the plate with developer in the usual way, and allow it to act until the shadows seem to fog slightly. At this stage an expert will examine the negative with his magnifier, and judge at once whether the dots on the shadows are sufficiently developed, and also if any access of density is required by them. But for a beginner to attempt this would result in having the negative stained; therefore at first the novice must content himself with developing as long as is safe without clogging the shadows. Now wash under tap, then fix in cyanide, and again wash. Then comes the examination. First of all see that the negative is clean and free from spots or stains, &c.; if not, put into a dish of water, and try again. If it is quite clean, get the magnifier and examine the dots on shadows, and if these are strong and of equal density all through, try the lights. Here we must have square opaque dots, the

corners touching distinctly—if they overlap, so much the better—and the space between the square opaque dots should be nearly transparent. All these points being correct, the next operation will be to clear the negative, this being done as follows :

Iodide of potassium	1 ounce
Iodine	¼ ounce
Water	20 ounces

Of this, take 1 ounce, to it add sufficient of a strong solution of cyanide of potassium to discharge the red colour, leaving the mixture quite clear, and dilute to 10 ounces. Give the negative a rinse under the tap ; drain slightly, and flood with the clearing solution. Allow this to act (carefully watching the negative) until the shadows just begin to brighten, then at once wash off the clearing solution. Now examine the dots in the shadows, and if they are reduced in size to a fine pin-point, growing larger and larger until the half-tones are reached, the action of the clearing solution has been good. Now look at the lights. Here the transparent dots should be clear and bright, whilst the opaque ones should just touch each other at the corners. If the above results are not obtained, a second application of the clearing solution will be necessary ; but great care must be exercised, or the whole image will be affected and spoilt. Never examine a negative without a previous wash, and do not be in a hurry, but apply the clearing solution again and again (washing between each) until the desired result is attained. The negative at this stage will be too thin for use, therefore it must be intensified. This is done by the lead method (pages 17 & 18). Bleach the negative thoroughly, wash under the tap until the yellow film is removed, then flood with the acid solution ; again wash and flood with the sulphide, wash, and clear with the acid solution. Again wash, and the negative is finished. Next examine the dots ; those in the extreme shadows must be merely pin-points, firm and shapely, and quite opaque, getting larger until the half-tones are reached. but still far apart and opaque. In the lights the opaque dots must be in perfect touch at the corners, and the transparent

centres between quite clear. Large dots in the deep shadows will cause flat results ; and if too small, or not opaque, they will cause sooty blacks.

To obtain successful results, care must be taken, first, in stopping the action of the clearing solution directly it has cleared the shadows on the transparent dots ; second, that the acid wash is used between all the stages of intensifying, with, of course, copious washing in between. A good negative has a nice silky look with it, but an indifferent one looks harsh.

The negative being finished, it must be drained, then flooded with a strong solution of gum arabic, carefully filtered, and again drained and dried. Careful operators can omit the gum varnish, but it is just as well to use it, as it renders the danger of scratching the film less during the printing.

Another method of finishing the negative is as follows : Bleach in a solution of copper bromide made up of

A.—Potassium bromide	1 ounce
Water	20 ounces
B.—Copper sulphate	2 ounces
Water	20 ounces

Dissolve separately, then when required mix in equal proportion.

When the film of negative is bleached right through wash thoroughly, then flood with a little of a solution of

Silver nitrate	1 ounce
Water	20 ounces

This will darken the film, then again wash ; now examine the dots carefully, the shadow dots must be quite apart from each other, and solid, those in the lights should be touching at the corners.

Now flood the plate with the iodine solution as above diluted with its bulk of water, this will again bleach the film ; when evenly bleached wash, then flood with a solution of

Potassium cyanide	1 ounce
Water	80 ounces

The action of this must be very carefully watched, else

VIEW OF PART OF BOLTON ABBEY.

[Made with a Levy Screen upon an Ordinary Gem Dry Plate, developed with Pyro Soda.]

the whole image will be dissolved by it. What it is required to do is to clear away the deposit in what should be the clear spaces.

When these spaces are clear, and the negative looks bright, and perhaps like a well exposed positive, wash off the cyanide, and again examine the dots; those in the shadows should be small and solid, the cyanide having attacked the edges, and cleared the weaker parts away; in the lights the dots must also be solid, the corners either quite touching each other, or nearly doing so, these conditions being right, give a final rinse, flood with

Nitric acid	1 ounce
Water	80 ounces

Again rinse, and blacken film with a little of

Sodium Sulphide	1 ounce
Water	10 ounces

Again wash, flood with nitric acid, then wash, drain, and coat with filtered gum arabic solution.

Before the negative is ready for printing, a great deal of after trouble is avoided if lines are cut through the film, leaving the required size of block inside the lines.

Any spots, &c., in negative may be touched up now, or left to the etcher.

In certain periods of the year, when using the wet collodion process, there is often a very distressing phenomenon—viz., screen-sweating. Sometimes this can only be got rid of by warming the screen before each exposure, but a very good remedy is to rub it over with glycerine or vaseline, and then polish off again. Whitewax dissolved in benzole can also be used, great care being taken to avoid leaving polishing marks behind; but the real remedy for this phenomenon is to keep the temperature of the studio perfectly even, then all the apparatus will be of one temperature, and sweating will be avoided.

CHAPTER III.

GRAINED NEGATIVES ON DRY PLATES

For this purpose the specially prepared gelatine dry plates, labelled "photo-mechanical" or "process" plates, are not the best; those that are called "half-tone process" will be found better. Failing these, any good ordinary plate may be used (in fact, some operators prefer them). The secret of success is simply this: be sure and have the light in dark room perfectly safe, then there will be no trouble.

The best developer for use is this:

No. 1.—Water	9½ ounces
Potassium bromide	90 grains
Nitric acid	10 minims.
Metabisulphate of potash	1 ounce.

Mix and pour into a 1-ounce bottle of pyrogallic acid.

No. 2.—Carbonate of soda (washing soda)	12 ounces
Water up to	80 ounces

For use for a half-plate negative take No. 1, 1 ounce; No. 2, 1 ounce.

As a rule, it will be found necessary to use a diaphragm a trifle smaller with gelatine plates than with wet collodion ones. A full exposure must be given, and at the same time care must be taken that the dots in shadows are not made too large.

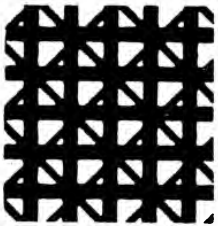
Development.—It will be found very advantageous in development to adopt Mr. A. Watkins' method of timing the operation, using his little instrument, the eikronometer, for the purpose. The method is as follows:—Have the

developer mixed, put the exposed plate into the dish (carefully shielded from any direct light), then turn the travelling pointer of the eikronometer close to zero, and when it touches zero, pour the developer over the plate (beware of air bells), rocking gently until there is the faintest appearance of an image. Then look at the eikronometer, note the time that has elapsed since the developer was poured over the plate, and multiply that time by six. Put the dummy pointer to the product, and when the moving pointer is opposite the dummy the negative is fully developed. Remove, and at once immerse in the hypo fixing bath. When all visible unaltered bromide of silver has been dissolved, wash the plate for half a minute, then immerse in a second bath of hypo of usual strength, and let it remain for at least five minutes, then wash and examine.

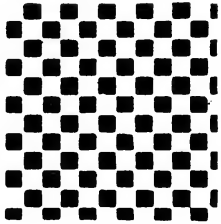
As an example of using this method of development, suppose that the action of light shows itself forty-five seconds after the developer is poured on the plate ; in that case, at the expiration of four and a half minutes from the time the developer was poured on, the negative will be fully developed. Of course, a watch can be used for the timing, but the eikronometer will be found a great convenience. The negative being fixed and washed, it must be examined with the aid of the magnifier, and the general appearance of the image should be about the same as in a wet plate negative, except that the opaque squares in lights should only just touch ; if over joined, there may be a difficulty in clearing the transparent dot. In the shadows the dots must be small, but opaque and quite free from raggedness.

Clearing the Negative.—This can be done either with the same solution as is used for wet collodion plates (used in a dish), or the ordinary reducer of Farmer's—viz., a mixture of hypo, 2 ounces ; water, 1 pint ; and as much of a saturated solution of ferricyanide of potassium as will suffice to make the hypo a yellow colour—or another clearing solution, made by adding 1 ounce of hydrochloric acid to a pint of the ordinary iron developer used for wet

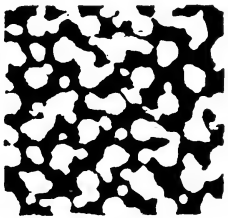
Crosslined.



Four-line.

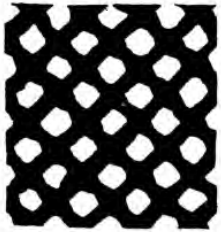


Chessboard.

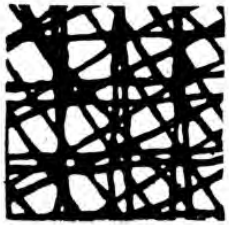


Combined.

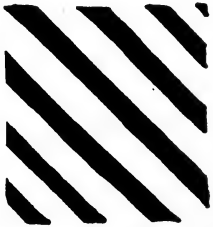
Grained.



Miller's Gauge.



Four-fold Silk.



Simple Line.

EXAMPLES OF VARIOUS SCREENS.

collodion, can be used. Whichever of these clearing solutions are adopted, it will not be necessary to give any prolonged washing to the negative after leaving the hypo fixing bath. In fact, for neither of the two last-named is washing required, especially if the second fixing bath is clean, as it should be, and will be if the negative is properly washed after being taken from the first hypo fixing bath. Whichever of the three clearing baths are used, the procedure is the same as for a wet collodion negative—viz., to clear away fog or veil from the shadows. When the operation of clearing is finished, a thorough washing must be given, and the negative then intensified.

To do this, it is first bleached until white in

Bichloride of mercury	1 ounce
Chloride ammonium	1 ounce
Water	20 ounces

When dissolved, add ½ dram hydrochloric acid.

When the negative is white, wash thoroughly, and then immerse in a saturated solution of sulphite of soda until the image is quite black through to the glass ; again wash, and allow to dry. The blackening of the washed bleached image can be done with a weak solution of caustic soda, or by immersion in a mixture of water 10 parts, ammonia 1 part.

Gelatine dry-plate negatives sometimes stain when intensified—that is because they have not been properly fixed—hence the necessity for using the two hypo fixing baths.

Plenty of washing is necessary between each operation, but unless the negative is properly fixed all the washing in the world will not prevent stains.

Before putting a gelatine negative to dry, always go over it with a pad of wet wool, to remove any scum that may be adhering to the film ; and if the negative be wanted in a hurry, soak for three or four minutes in clean methylated spirit, wipe over with the wool dipped in clean spirits, and the film will dry clean.

Dry-plate negatives are prepared for printing in the same way as wet collodion negatives.

CHAPTER IV.

PRINTING ON THE METAL.

The Enamel Process on Zinc.—What is called the enamel process is the one now almost universally used. Many formulæ have been published for the glue mixture, but this one has the merit of being well tried :

Le Page's fish glue	3 ounces
Ammonium bichromate	120 grains
Chromic acid (sat. sol.)	5 drops
Whites of fresh eggs	3 ounces
Water	10 ounces

This solution is carefully mixed, then filtered through flannel or felt.

The zinc plates must be round polished. They are cleaned first with a mixture of washed whiting and ammonia, this being rubbed on and off with a soft cloth. After this, wash and rub with a plug of lint or cotton wool ; then put on whirler ; whirl to get rid of water ; examine to see that no dust or dirt is on the surface of the plate, and if there is any, wash off. The plate being quite clean, flood with the glue mixture ; whirl ; again coat and whirl (this time gently), and hold over a good atmospheric gas-stove until the film is quite dry. Care must be taken not to dry too rapidly, or the film will scorch and be useless. The gas-stove must be a good one, burning with a clear blue flame, and the plate must not be approached too close. A good plan is to have either a gauze cover over the gas-stove, or to have an iron plate over it ; then the heat will be more even and under control. The film being dry and even,

with a nice enamel gloss, it is ready for the printing frame. Take the negative from which the print is to be made, warm it over the gas-stove, place the sensitive film in contact with the negative, put into printing frame, screw up, and expose to light. The exposure to light is not a very long one, from one to five minutes in good weather being an average. An actinometer may be used in dull weather, but in a fine sunlight timing will be found best, as also when electric arc light is used.

Developing the Print.—The print is put direct into water for one minute; then into a solution of a red or blue aniline dye, in which the image is stained; then upon washing away the film that has not been acted upon by the light, the image can easily be seen. After washing, if the colour has not had time to stain the image thoroughly, immerse again for a minute or two, then remove and wash. Now take the magnifier and carefully examine the print, beginning with the high lights; here we must have a perfect succession of dots, each quite apart from its fellows; there must be no break in the continuity of these dots; and they must be perfectly sharp and firm. In the shadows there must be a continuity of white dots in the film—very fine in the deepest shadows, and gradually growing larger to the darker half-tones; and unless the print answers these requirements, it must be at once washed off and another try made, because if the dots in lights are not clear, firm, and continuous—or the dots in shadows open—no amount of after work can produce a satisfactory block.

Burning in the Image.—The print being all right, it is well washed and dried, either spontaneously or by the aid of gentle heat; then it is ready for burning in, an operation necessary to enable the image to withstand the action of the etching acid. This burning in, or carbonising, ought to be done on a hot plate, but it can be done over an ordinary gas-stove, the plate being held in a small hand-vice. With zinc plates the greatest care and judgment are required not to carry the carbonising too far, or else the metal perishes and melts. At first the action of the heat de-

stroys the aniline colour, but directly afterwards the image assumes a light brown, which speedily gets darker; and if the plate be not now withdrawn, the image will become quite black, and simultaneously the metal will go, and the image turn to a grey. Therefore, be content with a dark brown image; it will give as good a resistance as is wanted, and be perfectly safe. Allow the plate to cool gradually, then it is ready for the etcher.

The above method, whilst indispensable for copper or brass, is not the best for zinc. The great heat required to carbonise the glue image makes the zinc brittle, and to a small extent spoiling its printing quality; therefore, when zinc is used for half-tone, sensitise with bichromated albumen (as given in Chapter III., Part II.) inking up the image after exposure with good litho-printing ink. When developed, dry the image and dust over with powdered dragon's-blood, rubbing the powder well into the ink; dust off the superfluous powder from the whites; then heat the plate until the dragon's-blood is melted, cool, and the plate is ready for etching, and the image will resist the acid quite as well as will enamel, or fish glue.

Printing on Copper.—Copper plates should also be round polished for half-tone blocks; they are cleaned with washed whiting and ammonia, then dropped into a weak mixture of water 1 pint, perchloride of iron solution (40° B) 1 drachm. Rock the dish for a moment, then remove plate and wash, and then immerse in a mixture of chromic acid 1 drachm, sulphuric acid 1 drachm, water 40 ounces. Here they will clear. Then thoroughly wash, put on whirler, and treat exactly as for zinc. All that has been written above for zinc applies now for copper, so there is no need to repeat the process—the only alteration necessary being this: Copper being capable of withstanding a greater heat, the carbonising can be carried further without any fear, the result being that a finer printing surface is obtained. Brass plates are manipulated exactly in the same way as copper right away through.

Failures and their Remedies.—A formula has been given for the fish glue mixture, but it is not possible to

give one that will always work properly, for the simple reason that all samples of fish glue are not alike ; hence it will often be necessary to modify the above formula, either by adding a little more glue, or a little more or less water.

If, when the print is placed in the dye, on lifting it out the image looks all right, but on washing the print the image comes away from the metal, then the film is too thick, and the glue mixture must be diluted. Under-exposure is shown in a nearly similar manner, except that the shadows do not come away so readily ; but the latter will, of course, occur in gross under-exposure. If the glue mixture is too thin, the image will not take up sufficient dye to give a good image ; and if burnt in, will either split up, or directly the heat has discharged the dye the image turns a dirty grey, and will not alter. If the glue in use is brittle, the addition of a little sugar to the mixture will counteract that defect ; and if the image looks spongy when dry, add a little gum arabic.

CHAPTER V.

ETCHING HALF-TONE BLOCKS.

Zinc Plates.—Before etching it will be necessary to see that the border lines are on the plate. If these are scratched through the film of negative, all that need be done will be to draw a fine line inside the black ones, so as to give a white line inside ; but if the border lines have not

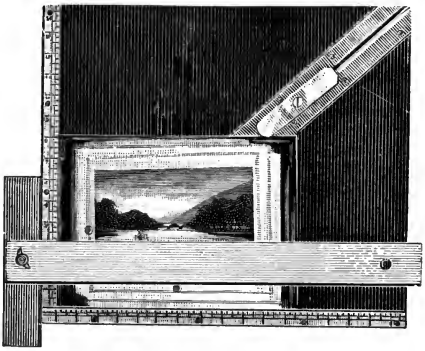


FIG. 13.—BOARD FOR LINING THE ZINC AND COPPER PLATES BEFORE ETCHING.

been cut on the negative they must be drawn on the metal with varnish. Also any touching up that is required should now be done, and the back and margins coated with varnish. (Fig. 13.)

The etching bath must not be too strong. Commence with a mixture of water 80 ounces, nitric acid 2 ounces,

and either rock the dish or brush over the plate with an etching brush. In the margin should be scratched a fine line or two as a guide during etching, but care must be taken not to scratch into the metal. As soon as these guide marks give a good grip to the finger-nail, remove the plate from the etching bath and wash and dry. Now paint over with resist, or stopping out varnish, all those parts which must print a rich black ; and when the varnish is dry, cut other guide marks in the margin and etch again. As soon as the new marks show a grip for the finger-nails, remove and examine the dots on high lights—they should still be firm and fairly *fat* ; if so, continue etching for a little time longer, and then remove and wash. Now paint out everything but the high lights, and again etch until the dots are reduced somewhat in size. Another plan is to apply the etching fluid with a brush on those parts it is desired to make print lighter. Both methods are good, and depend entirely on skill. In fact, after the first two etches, each plate will require to be treated in its own way. The one cause of failure in etching—*i.e.*, when the image is all right—is hurry. Take plenty of time, and examine the progress frequently with the aid of the magnifier.

After the first etch, it is often necessary to roll up the image in order to keep the dots from being eaten away whilst a little extra depth is being obtained. To do this it is necessary to provide a good glazed roller, charged with fine etching ink. The plate is warmed, and the roller passed over it, when the ink is deposited on the image ; if the glazed roller is charged with an excess of ink (the plate being hot), the ink will run over the edges a little and protect them, and afterwards the fine etcher can take advantage of these edges being a little under-cut to get brilliancy.

Copper or Brass.—For etching on copper or brass, perchloride of iron at 40° Beaume is best ; and as this mordant fills up the etched space, it should be followed by immersion in a solution of

Chromic acid	1 dram
Sulphuric acid	1 dram
Water	20 ounces

This clears away the deposit, and shows exactly what action has taken place.

The perchloride solution acts very slowly, but it gives a nice straight etch. Allow it to act for ten minutes, then remove the plate, wash, and immerse in the chromic acid for five minutes. This will clear away the dirty deposit, and will enable the action to be seen at once. Repeat the operations alternately until sufficient depth has been attained.

Part IV.

PHOTO-LITHOGRAPHY.

THE ORGAN-GRINDER.

[Specimen of "Li-pho" Process Lithography by Armitage & Ibbetson, Ltd., Lithographers, Bradford.]

CHAPTER I.

PHOTO-LITHOGRAPHY IN LINE.

THE process of photo-lithography is a means whereby a copy of a drawing, or engraving in line, dot, or stipple, in black ink on a white ground, can by photographic means be put upon stone, either same size, reduced or enlarged. Maps and plans, or sections of such, can be transferred to stone, and a great deal of costly and often unsatisfactory drawing work avoided; photo transfers, properly made, can be put down on stone, zinc or aluminium, as easily as an ordinary transfer written, drawn, or pulled from plate; and will give as good results. From lace curtains, lace and embroidery, exact *fac similes* are made quickly and cheaply for label and other work. Where several sizes of one original are required, one drawing only need be made (or set if for colour work), the other sizes being furnished as photo-transfers, enabling better work being put into the original, which will show itself all through the series.

The most important stage in the production of a photo-litho transfer is a good negative, in which the image is perfectly sharp from corner to corner, the lines being represented by clear glass, and the whites of original by as near opacity as possible. (N.B.—A photographic negative is the reverse of a positive, and is always judged by being looked through.) A tolerable idea of a photo-lithographic negative is seen in a reverse lithographic print in which the reading matter is represented by white letters on a black ground, except that when the film side of the negative is held next the face such reading matter will be reversed

as regards right and left. These negatives can best be obtained by the wet collodion process treated of in Part I of this book. A specially prepared dry gelatine plate, called the photo-mechanical, or process plate, can be used with good results.

The camera and lens are also very important factors in the production of a good photo-lithographic negative. The camera must be built for strength, not lightness, and must be of sufficient length to enable a copy to be made of the same size. Thus, for plates 15 × 12 inches, a lens having a focal length of 20 inches is requisite; therefore the camera must open out to at least 42 inches. Cameras made for out-door work with all the latest improvements are not at all suitable for copying, even if they do draw out a sufficient length, they being far too light to resist the slightest vibration. Cameras for photo-lithography are best without any of these improvements, which are a nuisance rather than a help.

The camera must stand on a solid box, moving on low wheels running in grooves, or upon rails. A good focussing eyepiece is requisite, so as to ensure absolute sharpness of image upon the ground glass.

The lens must be of Rapid Rectilinear, or, better still, the Anastigmat or Stigmatic type, and the focal length of lens should be equal to the diagonal of largest plate the camera will take, lenses of shorter focus being objectionable on account of the camera having to be so close to the original as to cut off light—hence uneven illumination, which will give rotten lines.

The room or studio in which camera is worked must be well lighted, and the floor solid, else the camera may vibrate during exposure, and the image be blurred. (Where it is not possible to get a firm floor, a swing stand, holding camera and easel, and suspended from roof or ceiling, will be necessary. See page 79.)

The easel or board upon which the original is fixed must be parallel with the front of camera, both horizontally and vertically, to prevent any distortion.

Whether work is done regularly or only occasionally,

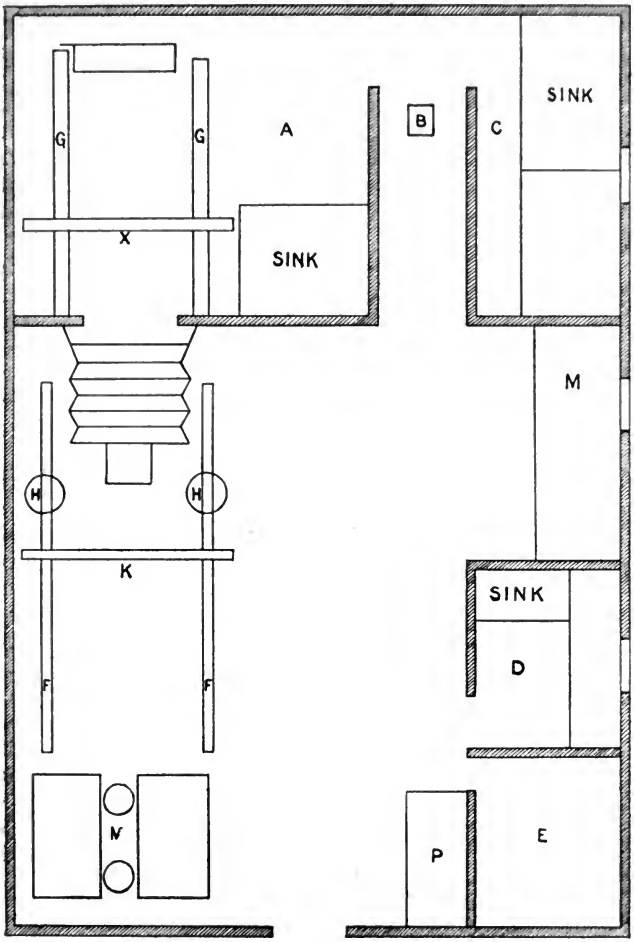


FIG. 14.

good apparatus and convenient workrooms are essential to success; whereas if the apparatus be unsuitable, and the working facilities meagre, it is almost impossible to turn out good work; the photographic manipulations require quite sufficient attention without having to fight with bad tools. Firms have tried photo-lithography and failed simply because the trial has been made with photographic apparatus not adapted for the process; but with suitable apparatus and properly fitted premises, photo-lithography is quite easy to work, and is of immense service to the lithographer.

Where large transfers are required, say up to 60 × 40, a camera built upon the same lines as one up to 24 inches by 20 inches would take up far too much room, and would also be difficult to manipulate; but by making the dark room do duty as camera and dark room, everything will be much simplified, and the initial expense much reduced. Fig. 14 will give an idea as to how such an arrangement can be made.

A is the dark room and camera. The size of room and length of bellows outside the room will depend entirely upon the focal length of lens; the bellows need only be about that length, leaving the rest of distance required inside. X is a stand moving on rails G G, to carry focussing glass, or sensitive plate.

For such an arrangement electric light is imperative—two lamps of from 15 to 30 ampères, hung on either side of easel K; the lamps being adjustable as to distance from each other, and so as to follow easel to and from lens.

K is the easel for carrying the originals, running upon rails F F; at B close to door of dark room is a stand upon which to coat the plates with collodion; C is a room in which the negative is intensified; at M is a bench for cleaning plates upon; D is a room for sensitising the transfer paper, and for inking up after printing; E is a room in which to dry the transfer paper after sensitising; P, a bench for cutting up the sensitive paper upon; N, two large printing frames upon swing stands and two electric lamps for printing the transfers.

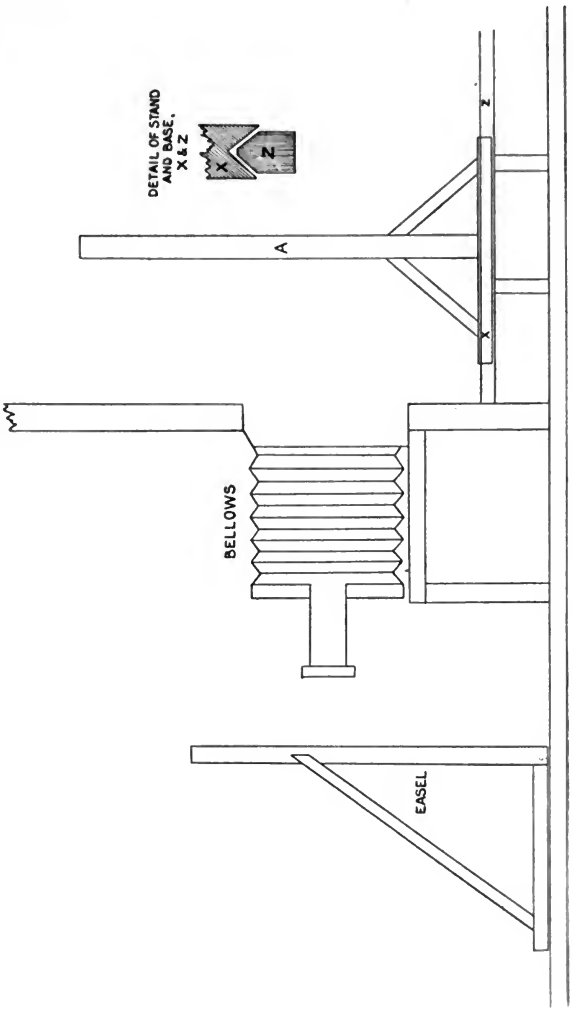


FIG. 15.

Fig. 15 shows detail of camera. The stand A slides backwards and forwards, to suit size of picture; and if the rail Z and base of X are of shape of detail, absolute rigidity is assured.

Fig. 16 shows the end of rail again, and also the detail of stand carrying sensitive plate. A is a frame sliding in grooves in uprights B B, and is kept at the desired height

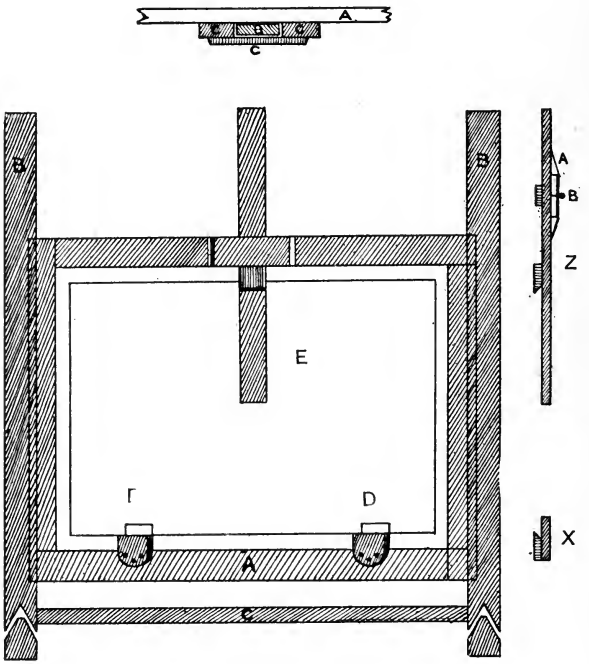


FIG. 16.

by a large wedge about 18 inches long by 9 inches high at wide end; this rests on shelf C, and is readily adjustable. The plate is rested upon holders at D D, and is clipped at top by sliding bar E; details of D D and of E being given at X, and of sliding bar at Z.

The silver bath may be in a large flat dish on a bench and provided with a cover to keep the solution clean ; but the best bath holder is that mounted upon a swing stand. In the illustration, Fig. 17, B is a wooden vessel made up of inch thick white pine, dovetailed at all joints, and put together with wooden dowels or pins, it being

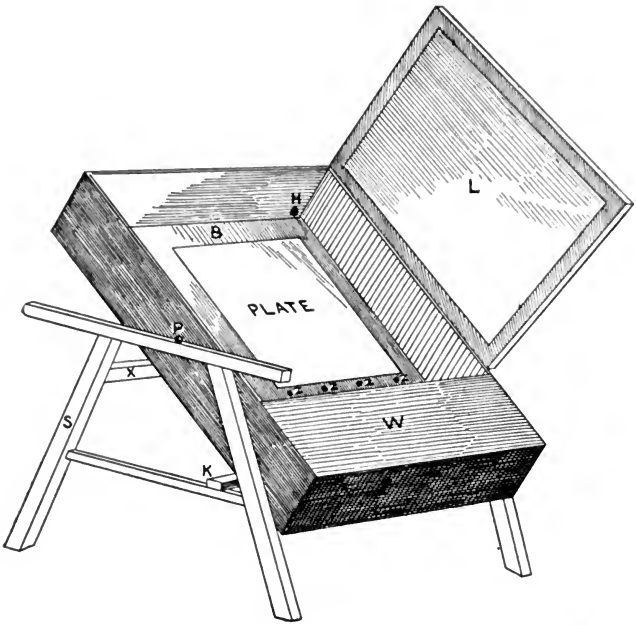


FIG. 17.—BATH HOLDER.

important not to use metal screws or nails in any portion of this holder. W is the well in which the silver solution is contained, *Z Z Z Z*, four or more turned knobs of wood sunk into the bottom, upon which to rest the plate when draining; S is the stand; L, the lid with drop hinges for removal when the bath holder is being cleaned out, this lid being a light frame covered with

American cloth—two thicknesses—smooth sides outwards; P, a pivot on which the bath holder can swing, resting on a bar K when plate is draining or when bath is not in use, and on the bar X when the plate is being sensitised, the pivot being so placed that the bath will lie flat when the bottom touches the bar X, the weight of silver solution being sufficient to preserve the inclination of holder when at rest. The bar X, being held in place by thumbscrews, is removable when the holder is to be emptied through the hole H, which is stopped by a cork when the bath is in use.

The holder must be made of well-seasoned wood, and be varnished inside with good black varnish, putting on six or seven coats, each one to be thoroughly dry before the next one is applied; and, in addition to being dry, it is advisable to expose to as strong a light as possible during the drying, because the bitumen is sensitive to light, and, unless this sensitiveness is destroyed by light, the action of the ether and alcohol in the collodion which gets into the bath solution, will dissolve the constituents of the varnish, and cause bath troubles.

The outside of the holder and the stand should be painted with a white or light coloured paint, so as to be plainly visible in the dim light of the dark room.

In Part I. a full description is given, with working details, of the wet collodion process, and if these details are carefully followed, and in an intelligent manner, little difficulty will be experienced in turning out good negatives; but the tyro must not expect to get good negatives straight away, practice and experience being as necessary in photography as in any other science.

Keep every bottle duly labelled; never mix any of the chemical solutions; keep all dishes for their particular solution; and, above all, keep everything clean. Keep the dark room for its special work, and do not make it a lumber room. Dust is a great enemy to good photography, and rubbish harbours dust, so keep dust out of the dark room. Let the only operations done in the dark room be collodionising, sensitising; development, fixing, washing and bleaching.

Clean the plates (except albumenising, which may be done in the dark room), and use the sulphide of ammonium outside. In fact, two dark rooms are wanted—one for the negative, the other for the other operations, including the making of the transfer. The negative dark room window will require an orange light, but the other dark room window can be covered with one thickness of yellow paper.

The Transfer is made by exposing to light in a suitable frame, under the negative, a sheet of paper coated with gelatine, and made sensitive to light by floating upon a solution of bichromate of potash. The light shines through the clear portions of the negative, such clear portions being the lines, dot and stipple representing the image. The gelatine beneath these is made insoluble, and incapable of absorbing water; but the gelatine under the opaque portions of negative representing the whites of original is not impressed by light, therefore it still retains its power of absorbing water. After this exposure to light under the negative the picture can be seen in brown lines on a yellow ground. The print is now covered with a thin film of transfer ink, and immersed in clean cold water, when the gelatine not impressed by the light absorbs water, and in a short time the ink on these portions can be wiped off; but on the lines where the light has altered the gelatine water is not absorbed, so the ink remains thereon, yielding a replica of the original, the picture being formed of transfer ink. Such, in brief, is the *rationale* of producing a photo-litho transfer; the description is simple, and so is the process—that is, if the proper tools are used.

The Transfer Paper.—This is a paper coated with a thin even film of plain gelatine. It can be purchased, ready for use, in sheets 25 × 19 inches (Jaffe's, Albert's, or Husnik's), or in rolls 12 feet long by 30 inches wide, from any of the makers of double transfer paper for carbon printing, some of the makers supplying paper specially coated for photo-lithography. To sensitise for use, any of these papers are immersed in a solution of potassium bichromate, squeegeed upon glass, and dried. This squeegee-

ing upon glass is an *absolute* necessity, for two reasons: first, because paper that is wetted stretches, and unfortunately does not stretch evenly—*i.e.*, it will stretch more one way of the web than the other; and, again, no two batches of paper stretch the same. Hence, to obtain a photo-lithographic transfer that is accurate in its dimensions, the paper is squeegeed upon glass; it dries at its full stretch both ways; it is exposed dry at its stretch, hence the transfer is exactly to scale of original; whilst if the paper be hung up to dry after sensitising, it is impossible to produce a transfer on stone correct as to both dimensions, although one of them may be made right by allowance in size when making the negative the other dimension must be out. The second reason is that without very great care it is not possible to dry the hung-up paper without some amount of insolubility of the gelatine being caused by impure air, &c., which tends to the production of rotten lines and uncertainty of result.

The best method of drying the sensitised transfer paper is the following:—Make a double dish a little larger each way than the sheet to be sensitised; thus for a sheet $25\frac{1}{2} \times 19\frac{1}{2}$ the dish must measure 27 × 22. The bottom of the dish is of plate glass, which is let into a frame about an inch wide (see Fig. 18—B B B). B is the frame of white pine, A the plate-glass bottom. The glass is bedded into a groove with putty or red-lead, the sides of frame being varnished with three or four coats of a good spirit varnish. By this method of sensitising, two sheets of paper are dried upon each sheet of glass, the wooden sides serving to keep the paper from damage whilst each sheet is manipulated, and to act as a dish for the sensitising previous to using; each time the glass is carefully cleaned, and polished with French chalk, which will prevent the paper from adhering to it when dry.

The Printing Frame.—This must be of the box pattern, with plate glass front, the pressure being obtained by means of screws. A good thick pad of clean smooth felt should be provided for each frame, so as to get the paper well into contact with the negative. The plate glass front should be

at least ½ inch thick, and great care be taken in screwing up so as to get the pressure even. In cold weather, after exposure outside, the pressure should be taken off slightly before taking the frame inside, or the sudden transference to a warm room will cause a smash.

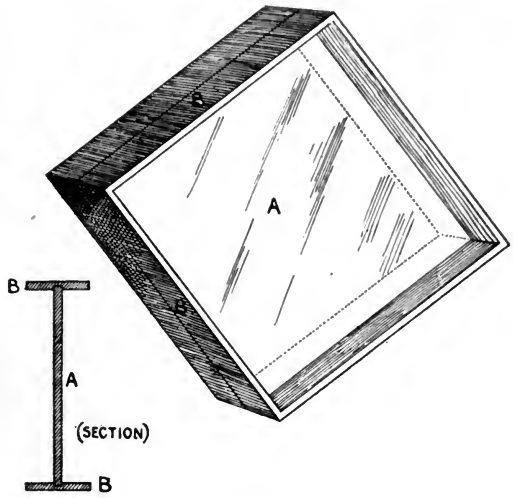


FIG. 18.

For printing from large negatives, and when tracings are used as the cliché, frames on a swing stand, fitted with pneumatic cushion back, must be used, such a frame being illustrated in Fig. 19.

The Inking Board.—This is formed of two boards hinged together, of the following dimensions :—For full sheets of paper, a small board 20 inches long, 3 inches wide, one side to be rebated ; the other board 20 inches long, by 24 inches wide, also rebated at one end. This rebate to go over the rebate on the small board, these two boards being hinged together at the rebated ends, with the hinges underneath, and sunk so that when the double board is laid on the bench it will lie flat.

When the board is made it must have three or four coats of good shellac varnish, so that when it is used for a small print the ink can be removed with a little turpentine and a rag. The size of board given can be easily modified for smaller transfers, one in which the smaller board is 12 × 3 inches, and the larger one 12 × 17½ inches, being a convenient size for half sheets of paper.

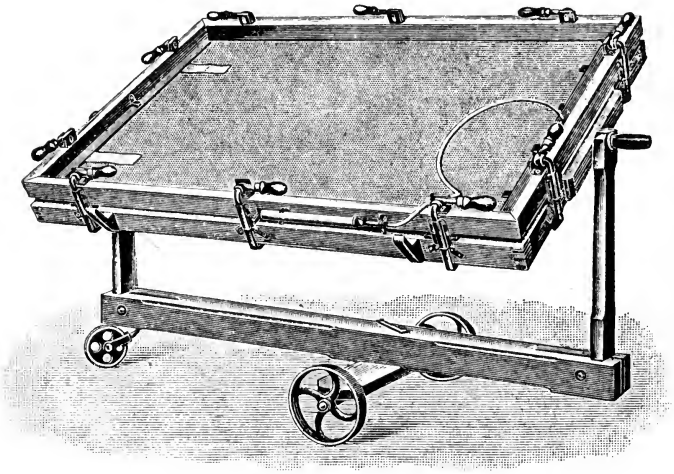


FIG. 19.—PNEUMATIC PRINTING FRAME.

The Roller.—To ink up the print after exposure to light a roller of gelatine, &c., as used by typographic printers, is the best; the method of using an inked stone in a litho press, and of rubbing on the ink with a rag or sponge being obsolete. This roller should be in a light frame, and the composition should be hard and with very little tack.

The Transfer Ink.—Any good re-transfer ink (stone to stone) may be used, either home-made or purchased. Penrose's Photo-Litho Transfer Ink is the best to buy, though the ink used by lithographic transferers will answer quite well, the requirements being a short, fatty

ink that will hold where it gets encouragement, but not where it is not wanted.

The following formula gives a first-rate ink for zinc printing, and also for photo-litho transfers :

Mutton fat	1 ounce
Beeswax, pure, not white	1 ounce
Soap	1 ounce
Shellac	1 ounce

The mutton fat is got by rendering in a clean earthenware vessel the best kidney suet, placing the vessel in the oven, and, when properly rendered, straining through muslin into another vessel to cool.

To make the ink, an iron saucepan fitted with a lid is required, and it should be made on a fire with an open chimney, to allow of firing the mixture during making. First put the mutton fat in the saucepan, and put on the fire. As the fat melts it will give out a crackling sound, and must be boiled until this sound ceases, and the liquid boils without noise ; now add the beeswax, a little at a time, and when this is all added, boil until quiet again ; then add the soap (any good, pure soap will answer), a little at a time, and when the crackling again ceases, add the shellac. By the time the shellac is dissolved, the mixture will be ready to fire ; apply a light, and let it burn until the whole is reduced in bulk to about half, then put on the lid of saucepan, which will extinguish the flame ; withdraw from the fire, and when somewhat cooler add 4 ounces of the best chalk litho ink, stirring it well until it is thoroughly mixed and melted ; then pour into a jar and allow to cool, and the ink is ready.

For thinning this ink a good sample of turpentine should be used, which should be perfectly free from paraffin oil, such an admixture resulting in dirty whites. Turpentine for this purpose is best purchased from a chemist who does not deal in paraffin oil. Those who do sell both are sometimes difficult to convince that merely using a funnel that has previously been used for the oil will spoil turpentine for our purpose. The writer has met with this difficulty, and, as the result was a lot of wasted time, deems it of

sufficient importance to give a word of warning to others.

Dishes.—These are required for sensitising the paper, and for soaking the exposed and inked-up prints; they may be of tin or of zinc, and should be of sufficient size to take the full size of print well. For whole sheets 26 × 20 × 4 inches deep, for half sheets 20 × 15 × 4 are good dimensions. Keep them for this purpose only, and keep them clean.

For wiping off superfluous ink, good surgical lint or fine swansdown is recommended; always have a good supply, and change it frequently so as to avoid dirty or scratched transfers. Clean blotting paper is required to free the transfers from surplus moisture before pinning up to dry, in order that they may dry flat instead of curly, as they are apt to do if pinned up without blotting off. When the transfers are flat, they are easily manipulated; if curly, there is always a risk of smearing.

The Sensitising Solution.—For photo-litho transfer paper the best all-round salt is the bichromate of potassium. The bichromate of ammonia *may* be used with advantage in very dark weather, or in hot muggy weather, but it is rather expensive, and the advantage gained is not of such a nature as to justify its employment always, a solution of bichromate of potash being capable of giving quite as good results. The bichromate of soda cannot be recommended, it being an amorphous salt, and deliquescent. Paper prepared with it must be kept so carefully as to be well nigh useless; the only advantage that is really claimed for it, viz., its increased sensitiveness, is not of sufficient importance to compensate for its drawbacks.

CHAPTER II.

PHOTO-LITHO TRANSFERS.

To sensitise the gelatine paper for photo-litho transfers make a solution of potassium bichromate 5 ounces, in hot water 80 ounces, and filter ; the bichromate being difficult to dissolve it should be powdered in a mortar.

It has been already explained that gelatinised paper for photo-litho transfers, must, after soaking in the sensitising solution, be squeegeed upon glass, and dried thereon, therefore before proceeding to use the above solution, the glass plates must be made thoroughly clean, first with hot water and soap then well rinsed, dried, and polished : after this polish dust over with french chalk (conveniently kept in a tin pepper caster) which must be thoroughly polished off. The plates used should be thin British plate either $\frac{1}{8}$ inch or $\frac{1}{4}$ inch in thickness, and the surfaces quite free from scratches.

In preference to these single glass plates, it is recommended that dishes made for the purpose, and shown in Fig. 18 be used, such dishes having many points of advantage in their favour.

To sensitise a sheet of gelatine paper in one of these dishes, place it on the bench (having, of course, previously cleaned and polished with french chalk both sides of the plate glass bottom), put into the dish a sheet of the gelatine paper face up, then pour over it sufficient of the solution of potassium bichromate to cover the paper ; now with a soft brush kept for the purpose, or with a pad of lint, go carefully over the surface and remove all air bells ; this done, lift the paper up and reverse it—that is, place the

gelatine surface next the glass, now quickly tilt the dish, and throw away the sensitising solution (taking care that the sheet of paper does not follow the solution), apply a flat india-rubber squeegee, gently to the back of paper all over, give a final rub over with a damp piece of lint (the lint being damped in the bichromate solution), also wiping the edges of dish free from any superfluous solution. Reverse the dish and proceed to sensitise in the same way another sheet. Then stand the dish up somewhere in the drying room till the paper is dry, when it will peel off the glass bottom of dish and is then ready for printing upon. Sensitive paper thus dried should not be taken off the glass until it is required for the printing frame, as it keeps in much better condition, in contact with the glass, especially if kept warm. A small drying room (as shown in Fig. 14—E) can be thoroughly well warmed with a small paraffin stove, or with one of the many excellent gas stoves now on the market.

Other sensitising solutions are

Albumen (white of egg)	10 ounces
Water	20 ounces
Bichromate of potash	1½ ounces
Liquor ammoniæ	½ dram

Dissolve the bichromate in the water, add the white of egg well beaten up, then the ammonia, filter through four thicknesses of muslin into a clean dish, and float the paper upon this for three minutes, then sensitise as given above.

Another method of sensitising is as follows. Make a stock-solution of gum tragacanth composed of

Gum tragacanth (in powder)	1 dram
Alcohol	1 dram

shake up well, then add

Water	20 ounces

this will at once result in a thick mucilage.

Of the above solution take	10 ounces
Water	20 ounces
Bichromate of potash	1½ ounces

filter this through muslin into a clean tin dish.

Before printing the transfer the negatives must be looked over, and any defects removed, pins used

to keep the drawing flat must be covered with a wash of india ink laid on with a sable brush, the holes in the film being also covered with ink. No particular care is requisite in doing this, except that the lines must not be touched. In cases where the picture approaches the extreme edge of paper, a wash of india ink will give a broader margin to the transfer. If a correction has been made on the original, and such correction is a strip of paper stuck on the face, the joint will show in the negative, and this must be covered up with the india ink. In extreme cases, where the original has been upon a yellow paper, or the picture was in pale or blue ink, a deal more painting out is sometimes necessary, and it is far better to do it on the negative than to do it on the stone. When this is all done, clean the back of the negative carefully.

In putting the sensitive paper upon the negative, care must be taken not to scratch the film, which is very tender and will not stand much hard usage. Cut the paper about an inch longer than the transfer is required, and having put the negative into the frame, film upward, place the paper, glazed side down, in contact with the film, put the felt pad upon the paper, then put in the back, and screw up, getting the pressure even all over. The frame is now put outside for exposure, to direct sunlight if possible. In a good light this exposure is not very long; for direct sunlight, from five to ten minutes being ample, if the negative is good. If this is at all weak a shorter time will be necessary, or the whites will be dirty; but with a perfect negative the time is not of much consequence. In dull weather the exposure will vary from half an hour to two or three hours. The progress of the action of light can be seen by opening one end of the frame, but this course should not be adopted until it is judged that the exposure has been sufficient, because relaxing the pressure and exposing the print to the influence of the atmosphere is apt to cause it to either expand or contract; and the exposure not being sufficient, the frame is closed and re-exposed, a blurred image will result, so that great care must be taken in making an examination of progress.

Directly the paper is dry, after sensitising in the bichromate of potash solution, great care is needed to shield it from white light, so the printing frame must be brought into the dark room for examination of the print. The print may be said to be sufficiently exposed when the whites are *just* beginning to show that the light has penetrated the opaque portions of negative.

When the print is sufficiently exposed it is removed from the frame, and is ready for inking up. To ink up the print, put a little transfer ink on the inking slab, sprinkle over this a little turpentine, mix the two together until thoroughly incorporated, the mixture being quite thin ; take the roller and roll in the ink ; now lift the inking board at the hinges, insert about half an inch of the plate in the slit, let the board go flat down, and the print will be held tight during the operation of inking ; now run the roller over the print from the top, lifting it each time as it gets to the bottom, until the ink is dry.

This is a very important stage. The film of ink put on must be thin and even ; if at all thick, the lines will squash in transferring. The film of ink put on must not be thick enough to obliterate the image, which should be seen through the ink. Beginners are apt to put on too much ink at this stage, and it is only after a little experience that the intelligent operator gets to understand the importance of a thin film of ink. More photo transfers are condemned because of over inking than from any other cause—in fact, it is a very common reason why these transfers are not liked ; they don't give sharp transfers, the reason being that too much ink has been put on.

The print being inked is allowed to rest a few minutes in order that the turpentine may evaporate, then it is immersed in clean cold water ; here it remains for about twenty minutes, when it is laid upon a sheet of glass or zinc, and the face gently rubbed over with a wet pad of lint ; this will loosen the ink from the broad whites, and partially so from the other whites. After a little further soaking all the ink on the whites can be removed, and if the yellow bichromate is also soaked out the transfer

is ready for blotting off; but if not, a longer soaking is necessary, as all the bichromate must be removed before the transfer is dried. The ink on the lines adheres with some tenacity, so that the rubbing with the lint to get all the whites clean can be done without fear of breaking or clearing the lines, so long as the transfer and pad are kept wet. In cold weather, or with old paper (*i.e.*, long sensitised), the water in which the print is soaked may be used warm, say 70° F., but the transfer will require more careful handling, as the ink is easily smeared.

After blotting off the transfer, pin it upon a clean board with a pin at each corner, leaving a little play, so that in drying the pins do not stop the contraction of the paper.

CHAPTER III.

DIRECT PHOTO-LITHOGRAPHY IN LINE.

To utilise a stone for this purpose is quite out of the question, for two reasons: first, on account of its cumbrous nature; and secondly, because of the porosity which effectually prevents any photographic method being of practical utility. Hence for a direct method we must utilise the more modern and convenient zinc or aluminium printing surface. These can be used *au naturel* or with a prepared surface, the last being the best, as the preparation of the plate, without in the slightest interfering with the sharpness of the image put upon it, helps the process of printing by giving a hold to the moisture, so necessary in lithographic printing to keep the whites clean.

When plain metal is used, it requires to be well polished, then grained by immersion in a mixture of

Nitric acid	1 ounce
Water	1 gallon
Alum	1 dram

This mixture is used in a large wooden tray lined with pitch, the plate being immersed until the polished surface is quite destroyed by the acid, leaving a dull matt-surface in its place. All the time the plate is immersed in this solution the tray must be kept rocking, in order to disperse the gas bubbles that otherwise must form upon the surface. After sufficient immersion in this acid-mixture the plate is removed, well washed under the tap, and the scum or oxide removed by gently rubbing with a very soft sponge

or a pad of wet lint or cotton wool; after this the plate is placed in a whirler and coated with a mixture of

White of egg	1 ounce
Water	10 ounces
Bichromate of potash	1 dram
Liquor ammonia	½ dram

the ammonia being added after the other ingredients have been well mixed together. Sufficient of this mixture is poured over the plate to well cover it, and it is then

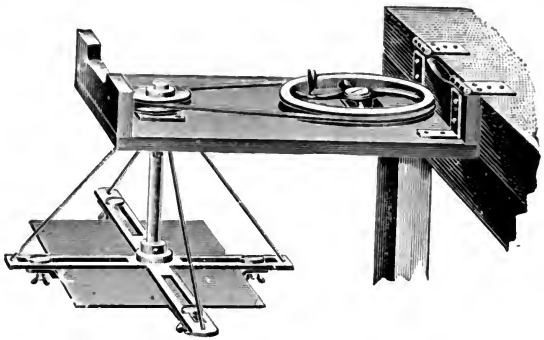


FIG. 20.—WHIRLER FOR LARGE PLATES

well whirled, in order to properly equalise the film. The plate is then removed from the whirler and the film dried over a spirit flame, or over a gas stove, the plate being kept moving, so that the film dries evenly. After this the plate is exposed in the printing-frame under a line negative; this negative being a reversed one—that is, the image is in its correct position as regards right and left when the film is held next the face. The exposure to light, inking up, &c., are the same as for paper transfers; and the subsequent working, either for transfers or for working on machine, will be just as usual for ordinary zinc plates.

The prepared zinc and aluminium plates now in the market, and used for originals, and also as substitutes for stones, are admirable for direct photographic printing, and require no preparation of any kind previous to coating

with the sensitive mixture. This mixture—bichromated albumen, as given above, or bichromated tragacanth, as given in Chapter II.—is flowed over the plate and whirled, then dried over a spirit flame or a gas-stove, after which it is ready for exposure under the negative. The inking-up is done with a glue-roller and transfer-ink thinned with turpentine, the rolling being continued until the turpentine has evaporated, leaving a thin even film of ink upon the surface; this film of ink must be thin, or the image will be thick. This is a crucial stage, and one that is very difficult to describe, so the learner must be prepared for a few experimental trials at first. It is, however, far easier to put too much ink on than too little; in fact, it is almost impossible to put on too little.

There is one drawback to the use of these prepared plates, viz.—once used, if the print is from any cause a failure, the plate will have to be used as a piece of plain metal (after cleaning off the image and preparation with a rag dipped in pumice powder), or be returned for recoating; but if the negative used is a good one—*i.e.*, has *perfectly clear lines*, with opaque whites—and sufficient exposure is given in the printing-frame, there is very little reason for failure. The plates, being flexible, can be examined when in the printing-frame, and that without any risk of contraction or of expansion, as is the case when paper is printed upon; absolute scale and size can be relied upon with these plates, as they can be used either as originals from which to pull transfers, or can be printed from on machine or press. Direct photo-lithography must command a position of usefulness.

CHAPTER IV.

PHOTO-LITHOGRAPHIC TRANSFERS WITHOUT A CAMERA NEGATIVE.

To make lithographic transfers from a tracing, without the intervention of a camera negative, a negative is made by contact in a printing-frame by the subjoined method, on a thin paper, and from this negative the transfer can be printed as from the usual camera negative on glass. A tracing for such a purpose should be made upon thin white tracing paper or cloth, not upon the yellowish brown variety often used. The lines must all be drawn firmly, and made as near opaque as possible, then little or no work will be required on the stone.

Thin Saxe, or Rivé, paper is coated with the following mixture :

Ammonium ferric oxalate	1 ounce
Water	5 ounces

dissolve, add 2 drams of a 5 per cent. solution of gum arabic, and 40 grains citric acid.

In another bottle dissolve

Nitrate of silver	60 grains
Water	2 drams

when dissolved, add

Citric acid	60 grains

when dissolved, add ammonia, ·880, drop by drop, stirring between each addition until the precipitate formed by the first addition of ammonia is almost re-dissolved, the solution to remain slightly milky; now add this mixture to the ferric oxalate solution, a little at a time, constantly

shaking the bottle. When the mixture is complete, the solution must have a greenish tinge, and be slightly opalescent; if at all red, add a quantity of a 20 per cent. solution of citric acid.

The paper to be coated is pinned upon a large smooth board, the above mixture being spread over quickly and evenly by means of a pad of swansdown. The quicker this operation is effected the better. Hang up to dry in a warm room.

To print, use a printing-frame fitted with air cushions, so as to ensure absolute contact with tracing. The time of printing is best gauged by means of an actinometer, made up of an ordinary half-plate printing-frame, in which is a small tracing, with a piece of paper prepared with the same solution as used upon the larger sheet; the action of light being visible, examination of this small frame will allow of the exposure of the large sheet being timed quite accurately, the printing being carried as far as the weaker lines in tracing will allow.

When the printing has proceeded sufficiently far, remove the paper from printing-frame, and immerse in a solution of

Citric acid	1 ounce
Water	80 ounces

for about five minutes, or until the yellow tint is removed; wash in five or six changes of water, immerse in

Ammonia ·880	1 ounce
Water	80 ounces

for five minutes; wash in three or four changes of water, then place negative face down upon a sheet of glass, gently squeeze the back to get rid of as much moisture as possible, and hang up to dry. When dry use exactly in the same way as a camera negative would be used for making the transfer from on paper. Or the following method, introduced by Mr. T. A. Pope, Assistant Surveyor-General of Canada (in this process the ink itself is made sensitive to light, and ultimately forms the printing lines): One ounce of ordinary photo-transfer ink and ½ ounce of good

soap (Sunlight soap answers well) are well mixed together upon a slab; then add 1 ounce of ammonia bichromate dissolved in 4 ounces of water, and mixed with 4 ounces of fish glue; when the whole is thoroughly incorporated, thin with turpentine until of almost liquid consistency.

With either a soft glue roller, or sponge, coat a zinc plate quite thin and evenly (this coat must be quite thin, or light will not be able to penetrate sufficiently deep to fix the lines to the metal). When this coating is dry, expose under the negative for ten to fifteen minutes in sunlight. If a glass negative is used, it must be "reversed"; a paper negative can be used with the proper side next the zinc plate to give a reversed (right and left) image. After exposure, with a glue roller apply a thin film of photo-transfer ink and let it dry; now soak in water for fifteen minutes, then rub whites clean with cotton-wool. When clean, immerse in a solution of

Alum	5 ounces
Water	100 ounces
Nitric acid	1 ounce

This removes any traces of fish glue from the whites, and converts the soap into a fatty substance. The plate is now handled by the lithographer in the usual manner.

CHAPTER V.

HALF-TONE PHOTO-LITHOGRAPHY.

In photo-lithography in line the transfer is made from a subject in which the half-tones are translated into line, dot, or stipple by the draughtsman; in photo-lithography in half-tone the translation has to be effected by mechanical or chemical means.

Nearly all the mechanical methods yield results that are either unsatisfactory or require an inordinate amount of hand work upon them, which detracts from their utility. The most commonly used method is either a transfer from a half-tone block or a print from a grained negative upon the usual chromated gelatine paper, but whichever way is tried the results are rarely satisfactory. The dots are too close together, in both lights and shadows, for lithographic printing; this class of grain being essentially for letterpress work, where the effects of gum and water upon the ink has not to be contended with.

The new metzagraph screen introduced by Mr. Wheeler, of Watford, is the most likely mechanical method of breaking up the half-tones, and it is easy to work (no complicated series of various shaped diaphragms, differential screen distances, &c., being needed); in fact, its use is quite simple, the screen being placed in as near absolute contact as possible with the sensitive plate, an ordinary shaped small diaphragm in the lens, supplemented by a short exposure to a piece of white paper, in order to get grain in the shadows. From these negatives transfers are made exactly as from ordinary line negatives, and the transfer to stone

is just as easy; the result has all the appearance of a good chalk lithograph.

The chemical means of breaking up the half-tones depends upon very simple facts, the chief of which is "that a film of bichromated gelatine dried by heat will reticulate, and that reticulation will be finer or coarser according to the thickness of the film of bichromated gelatine on the plate. The mere drying of a film of bichromated gelatine is not sufficient to cause a reticulation of such coarseness as to work from stone; but if various substances are mixed with the gelatine, then the reticulation can be made to assume very large proportions. Calcium chloride, ferricyanide of potassium, silver nitrate, &c., are examples of such substances, and by their aid, separately or mixed, a successful half-tone photo-lithograph is possible.

Photo-lithographic transfers can be made direct, or from a collographic plate, and here again little choice is possible. The direct methods—*i.e.*, using paper as the support for the bichromated gelatine—are not sufficiently certain to enable them to be used on a commercial scale, the difficulty in working being caused by the thick coat of gelatine necessary to get a workable grain becoming unmanageable during the manipulations. The best method is the collographic, in which the gelatine is spread upon a glass plate, and from this the transfer is pulled in ordinary transfer ink upon Scotch or India transfer paper, and as each plate will yield at least twenty-five transfers, the process is far more certain than when a transfer paper is used, and which in case of accident will have to be done over again, entailing a delay of at least a day; and an accident can easily happen, a little too much ink on the print, or a slur in transferring, all will crop up occasionally.

This method of making transfers in tone lends itself thoroughly to photo-chromatic printing, the key plate being made from the collographic grained transfers, the colour scheme being worked out on sets-off from this key.

CHAPTER VI.

PHOTO-LITHO IN HALF-TONE FROM COLLOGRAPHIC PLATE.

For this process a collotype oven will be required capable of being heated up to 180° Fah. A full description of this oven will be given in Part V., dealing with the collotype process. The plates must be dried in such an oven, as the success of the process demands that, to obtain the necessary grain, the gelatine must be dried at a high temperature.

The Plate.—British plate glass is used to put the sensitive film upon, as that alone can be used economically. Plates of brass or copper may be used, but they are so easily bent that they are not recommended. Thin zinc or aluminium, as sold for lithographic work, can be used. The plate glass used should be at least $\frac{3}{8}$ inch thick, but it will be far the best to have it $\frac{1}{2}$ inch thick; this thickness is more expensive at first, but it pays best in the long run, as it withstands the pressure in press better.

The plate is ground on one side with fine emery, then well cleansed and scrubbed in order to get rid of all traces of the emery; a final cleanse with soap powder and a thorough wash will render the plate ready for the substratum.

The Substratum.—If the film of gelatine be dried upon the glass without any substratum it will not hold on sufficiently to enable a print being pulled, but with a good substratum the film will hold as long as required. The

plate is dried, then covered with a little of the following mixture :

Dextrine	1 ounces
Water	10 ounces
Silicate of soda (syrup)	2 ounces

This mixture must be well filtered before use, and will keep mixed for weeks. When the plate is coated it is stood on a rack to dry in a warm room, and when quite dry is rinsed under the tap to wash away any free silicate there may be. After rinsing, the plate must be again dried, then it is ready for the sensitive coating.

Zinc, aluminium, or copper plates do not require this substratum.

The Sensitive Coating.—When dried after rinsing, the plates are placed in the oven and carefully levelled, then warmed to about 130° Fah. Whilst the oven and plates are being warmed the sensitive mixture is made up as follows :

Soft gelatine	1 ounce
Water	5 ounces

Soak gelatine in the water, in a clean jar, till quite soft, put the jar in a pan of cold water, place this pan on a gas stove, and gradually raise the temperature until the gelatine is melted, stir with a glass rod to facilitate the mixture ; when the gelatine is dissolved add

Bichromate of potash	75 grains

in a fine powder, adding a little at a time, and stirring well until dissolved. Next add 10 grains of calcium chloride ; when dissolved and mixed add 30 grains of ferricyanide of potassium, previously dissolved in 1 ounce of hot water ; finally, add 10 drops of acetic acid, strain through muslin, and coat the warm plates, allowing 1½ ounces of the solution for a plate 15 × 12, this being at the rate of four minims per square inch. As the plates are coated return to the oven, and when both plates have been coated close the oven, and dry at a temperature of 140° Fah. The drying will occupy about one and a half hours, and the temperature should be kept steady ; when dry, again coat whilst still warm with the same quantity of gelatine mixture,

return to oven, dry, then cool, and the plates are ready for exposure.

Exposing to Light.—The negative must be reversed, and must be rather flat, with all detail present; it may be made by any process, wet or dry.

The time of exposure will vary from three hours to all day, according to the strength of the light, and this can only be accurately determined by practice. It is far better to err on the side of too much than too little, because an over-exposed plate will yield a good transfer, but one under-exposed will not do so.

If the negative is smaller than the plate the edges of plate must be protected from light by a mask, else it will be difficult to get a clean transfer, on account of the ink coming off the margin. The printing frame is the same as used for collotype printing, pressure being obtained by means of wedges. When the exposure to light under the negative is completed, the plate must be placed in a dish of water at 100° Fah. for from one to five minutes, according to the grain required—the longer the plate is in the hot water the coarser the grain—it is then washed in cold water for about six hours, and carefully dabbed dry with a soft cloth; then stand the plate on edge to dry.

Pulling the Transfer.—For this purpose a lithographic press is used, the glass plate being placed upon a lithographic stone, with a sheet of wet blotting paper underneath the glass plate. The back of the glass plate must be carefully cleaned from gelatine that may have run over the edges; grit, &c., must also be cleaned off. If these precautions are not observed the chances of a smash are many. Cover the surface of plate with water 1 part, glycerine 1 part, and let it stand in a pool all over whilst preparing the roller and transfer ink. The roller used is a good black lithographic roller, the ink a good re-transfer ink (stone to stone), used a little stiffer than for ordinary transfers. When it is judged that the plate is sufficiently wet ("etched" is the usual term), remove the glycerine with a sponge, then dab with a soft rag, and proceed to roll up; the ink does not at first take very kindly to the image,

but, with patience, it will soon ink up nicely. Do not try to get a vigorous image, as such a one will be troublesome in transferring. When the image has been rolled up, clear it with a good composition roller, such as is used for collotype, or with an indiarubber roller ; then pull a proof. If the proof is satisfactory, damp over with a wet sponge, dab with soft cloth, roll up again, and pull a proof upon well rolled Scotch transfer paper, or upon India transfer paper, and repeat the operation until a sufficient number of transfers are obtained.

Should the plate roll up black, and refuse to clear with quick rolling, wash out with turpentine and water in the usual way, then etch for twenty minutes with :

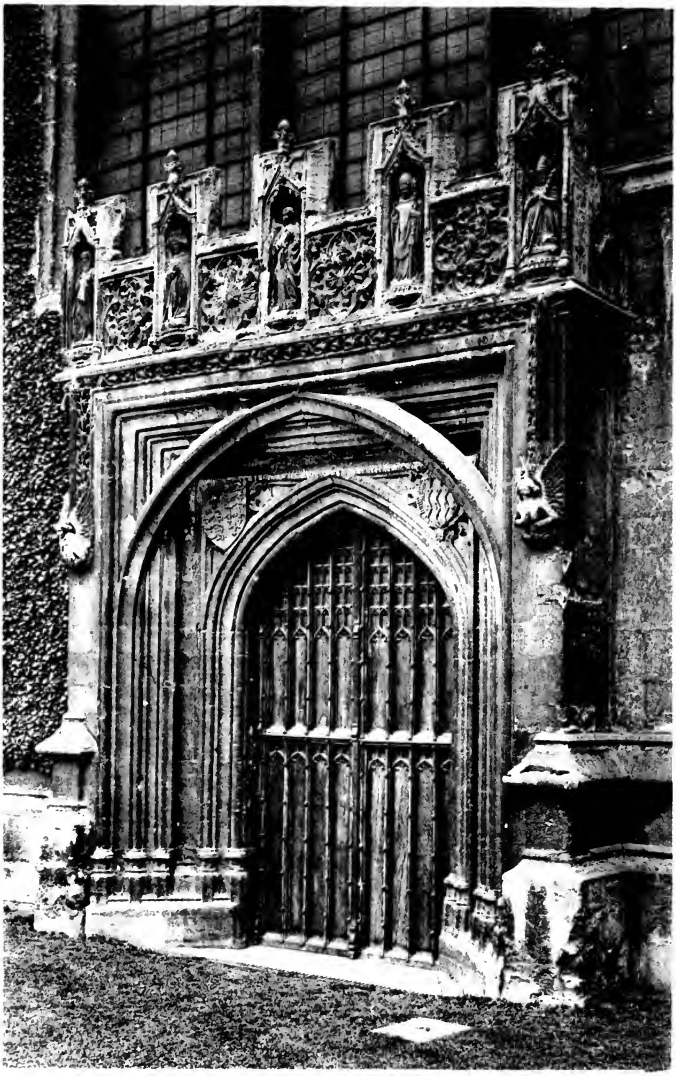
Glycerine	1 ounce
Water	5 ounces
Liquor ammonia	½ dram

Cover the whole film with this, removing when time has expired with a sponge, returning to bottle for future use ; roll up again and try proof. Should the image refuse ink from the roller try a thinner ink on the roller, and if this is not efficacious, let the film dry a little.

The printing of these transfers is much the same as collotype printing, and the tyro will be repaid by reading the chapters upon Printing from the Collotype Plate in Part V.

PART V.

COLLOTYPE.



WEST DOOR, ST. MARY MAGDALEN COLLEGE, OXFORD.

From Neg. by J. W. Hodges, F.S.M.C., Blackheath.

Collotype by MORGAN & KIDD, Richmond, London, S.W.

Photo-Mech. Processes.

CHAPTER I.

COLLOTYPE.

COLLOTYPE is the simplest and easiest photo-mechanical process, but it must be installed under suitable conditions; damp and cold are its greatest enemies. During the preparation of the printing surface, and right up to the time the plate is placed in a water bath to get rid of the bichromate, damp must be avoided; whilst the sensitive film is being dried vibration must be guarded against, or the plate will be useless; and the press-room must be kept at an equable temperature all the year round, not icy cold in the morning and a gradually rising temperature during the day, as this gives uneven results—grey and flat at first, improving after, but the improvement is obtained at the expense of wasted ink, time and energy.

It is undoubtedly the attention paid to these points that helps Continental firms to produce collotype so much more economically than is done in England, but they do not produce a higher quality than is done here under congenial conditions. Continental firms fit up their premises thoroughly, and are able to do good work all the year round; in England the majority of places are not fitted up properly, hence in cold damp weather the results are bad, and the process is called uncertain, which it is not.

The routine of the process is as follows:—glass, brass, copper or aluminium may be used as the printing surface—glass is usually used as it is cheapest. All metal plates are uncertain as regards perfect flatness, the heat of oven and pressure in printing press speedily spoil them.

The glass plate is ground with fine emery, washed, and given a coating of a thin colloid mixed with a soluble silicate; dried, again washed, to get rid of any soluble silicate, once more dried, and it is ready for the sensitive coating.

The object of the silicated colloid is to form a thin film upon the surface of plate to which the sensitive gelatine can attach itself perfectly; without such a substratum it is found impossible to get a film of gelatine to withstand the process of printing. Metal plates, however, do not require this substratum.

In an oven or drying box the silicated plate is levelled, and warmed to 120° Fah., then covered with a 10 per cent. solution of gelatine mixed with an alkaline bichromate (potassium bichromate being, perhaps, the best), and returned to oven till dry. When dry and cold, the now sensitive plate is exposed to light under a negative, then the bichromate is washed out in cold water; when clear of the bichromate, the plate is dried in order to somewhat harden the film for the operation of printing, which is done upon a press (letterpress, lithographic or collotype). After the film has been made ready for printing by being soaked with glycerine and water, which will be absorbed by the gelatine not exposed or only partially exposed to the light under negative, whilst the shadows and darker portions more or less exposed to light will reject the glycerine and water, and when a roller charged with fatty ink is passed over it will take the ink from the roller, and so form the image, which is transferred to paper by the pressure of the press. Such is the process—simplicity itself. Providing that the installation is perfect the results will also be perfect.

First of all, the oven room claims attention. It must be free from draught and free from vibration, and entirely free from damp. The accompanying sketch plan (Fig. 21) will be useful as a guide. A, A, A, A, four ovens, each holding two small plates 15 × 12, or one large one about 24 × 18.

The plates must always be prepared in pairs, because the only way to keep them even a few hours is to place them

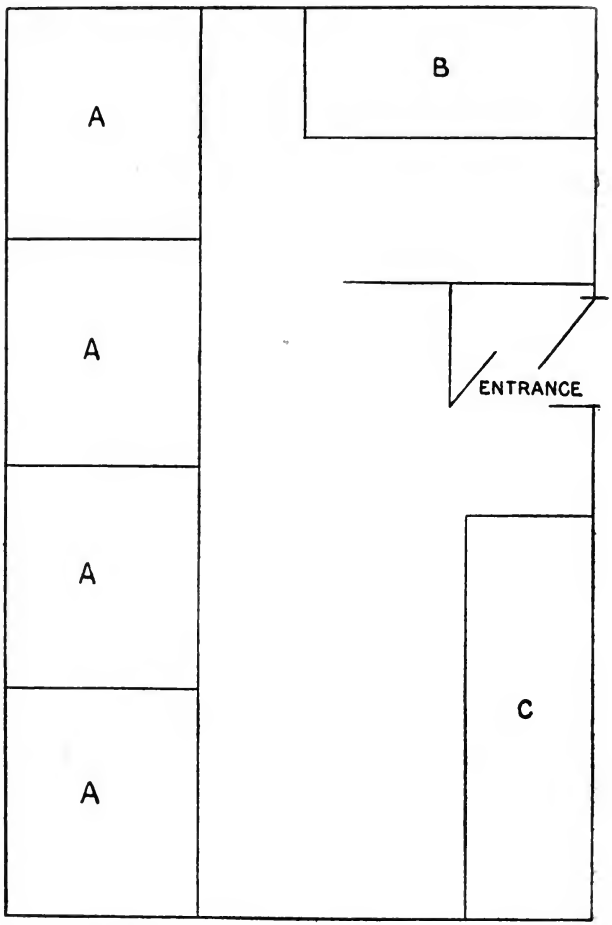


FIG. 21.—PLAN FOR COLLOTYPE PLATE PREPARATION ROOM.

face to face just before they are cold; if this is not done, the film is likely to be damp struck, and go insoluble, and once the film is insoluble the shadows will glaze, and there is no possible chance of getting the grain to develop in the shadows, which, in consequence, will be sooty instead of clear and open. This, and drying the sensitive coating in an unventilated oven, which results in a baked film, accounts for the flat washy collotypes so often seen. B is a bench fitted with a gas stove for the preparation of the gelatine mixture; C a bench upon which the printing frames are filled in previous to exposure to light, a window in front giving ample light for the purpose. For daylight illumination of the room, cover the window with one thickness of yellow fabric or tissue paper. For artificial light (gas or incandescent, electric) any amount of light is quite harmless.

The Oven.—A very good model of a single oven is illustrated by Fig. 22, which in the case of a large establishment is doubled or quadrupled. It is an oblong box of a suitable size for the particular plates dried in it; and as the actual cost of coating a plate is so small it pays best to have only one, or at most two sizes of plates in use. This will be specially the case when a machine is used for printing. In building an oven the maximum size of plate should be ascertained, and the oven made to take two of them. The dimensions of an oven to dry two plates, each 15 × 12 inches, will be 32 inches long, 20 wide, 24 deep; and if more than two plates are to be dried at a time, the arrangement shown in Fig. 22 is recommended.

The body of the oven, as above, is of wood 1 inch thick, and stands upon four legs 18 inches from the ground. The bottom of the oven is an inverted tray made of thin sheet iron 32 inches long, 20 wide, 9 deep (or high). This is screwed to the bottom of the wooden body, the top of the sheet iron tray forming the bottom of the oven. At each side of the tray will be a space between the wooden side and the side of the top of tray forming a ventilating space for the admission of cold air into the oven. The appliance for heating may be a long atmospheric burner supported

upon bricks under the mouth of the sheet-iron tray; or if the tray is fitted with a ventilating pipe, a U-shaped burner fitted with four small burners upon each arm may be used. Paraffin stoves can also be used for warming the oven, but they require an inordinate amount of watching to prevent

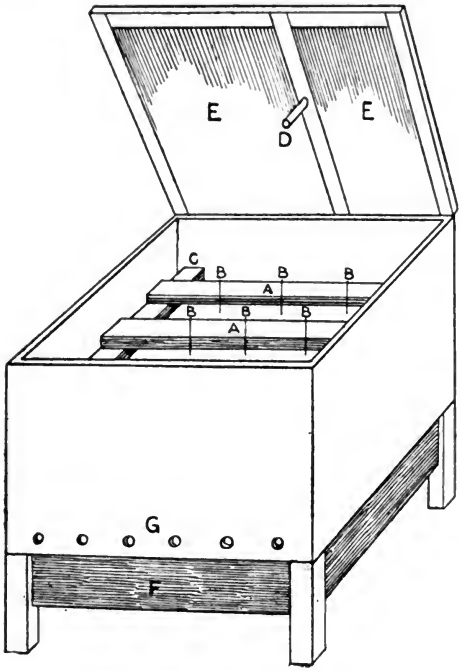


FIG. 22.—COLLOTYPE OVEN.

A A, Iron bars; B B B, Iron thumb screws; C, Supporting cleat; D, Thermometer; E E, Lid; F, Sheet iron curtain; G, Ventilation holes.

smoking. The lid of the oven is formed of two frames fixed at the corners, one above the other. The lower one is covered with common red flannel, the other with American cloth. The supports of the corners will leave a space of

about $\frac{1}{2}$ inch, through which the heated air can escape. In the centre of the lid a long glass thermometer projects, the index being outside, but the bulb close to the plates when drying. The plates are supported upon bars, two bars for each plate. One bar has two long screws 9 inches apart, the other bar one screw in the centre only. These screws are about 6 inches long, $\frac{1}{4}$ inch in diameter, and the bars are supported upon cleats screwed upon the sides of the oven about 12 inches from the bottom.

Glass Plates.—These should be of British plate glass, at least $\frac{3}{8}$ inch thick ; $\frac{1}{2}$ inch is better, as they will bear far more pressure, and are not so liable to break during printing. The plates are to be ground upon one side with fine flour emery, using a small piece of plate glass as a muller. Very fine flour emery must be used, as if the emery is at all coarse the result will not be good. The Wellington knife polish, sold in tins, is a good article for the purpose, and can be purchased in places where flour emery is not procurable. After grinding, the plates must be well washed and scrubbed with a brush, and this brush must be kept for the purpose, and free from contact with soap or grease. The above remark refers to new plates ; plates that have been used will require to have the old film removed. This can be done by immersion in a strong solution of potash lye washing, grinding with emery, re-washing and scrubbing. Or the old film can be removed by means of a mixture of 2 ounces of fluoric acid and 20 ounces of water. Sufficient of this mixture to cover the film is spread all over with a piece of rag (don't touch it with the fingers), and the film will frill and come away in a sheet. After this the plate only requires washing and scrubbing. A final rinse and a scrub with a dry soap powder, such as Hudson's, is a very good preventive of grease.

Gelatine.—This must be of the best quality, Kreutz's or Simeon's being the best in the market. In summer time hard gelatine is required, in winter a mixture of hard and soft is better ; a good supply should be got at a time, because no two samples are alike. Each will accordingly require different treatment, only to be determined by

experiment. Gelatine must be stored in a perfectly dry place; damp will soon spoil it.

Bichromate of Potash.—This must be pure and in fine powder. Bichromates of ammonia or soda are not recommended, both being uncertain in their action.

Printing Frames.—These are of the box pattern, with plate glass fronts, the pressure behind being obtained by means of wedges. It is not usual to employ the ordinary

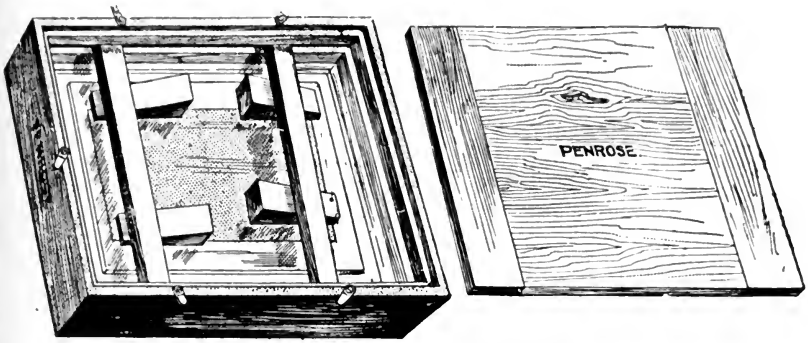


FIG. 23.—COLLOTYPE PRINTING FRAME.

back to these frames, but to have for each frame a shallow wooden box; this keeps out white light from the back of the sensitive plate, and allows the progress of exposure to be ascertained without the risk of moving, as is the case when a back has to be opened.

Tinfoil.—Very thin tinfoil is fixed on the face of the negatives on glass to mark out the exact portion of the image required, and to give the sharp line required for pictorial effect. This tinfoil is attached to the film by a thin india-rubber solution. When flexible negatives are used masks are made by cutting out openings in thin opaque paper, the negatives being attached to this paper.

Miscellaneous.—Amongst the miscellaneous articles required will be test tubes and beakers; these are for holding the gelatine solution when hot and ready for coating the plate. Measured quantities must be used for this

purpose, and as glass measures are so easily broken by heat, it is recommended to use test tubes, or beakers, with the quantities required marked upon the sides by a file. Funnels for filtering are wanted, and may be of tin or glass. Cotton-wool, or fine swansdown, is used, the last being best, as it can be used over and over again if it is carefully cleansed after each time of using.

For dissolving gelatine a water bath is always employed; to attempt the direct application of heat to the vessel containing the gelatine is to quite spoil it. Gelatine should be thoroughly soaked in cold water before heat is applied for the purpose of dissolving. For this purpose small jam jars are useful, the jar being put into a tin pan when it is to be heated; the tin pan being in turn placed upon a gas stove, or, failing this, a paraffin stove. Either of these stoves would be preferable to an ordinary fire, being free from soot and smoke, which cannot be avoided in an open fire-place.

Silicate of soda or potash are met with in commerce in two forms, viz., in a broken cake and in the form of a thick viscid liquid. This latter form must be used, the solid silicate being practically useless. Dextrine is used with the silicate to form the substratum, and either the white or yellow variety may be used.

CHAPTER II.

PREPARING THE COLLOTYPE PLATE.

To prepare a collotype plate the following operations are necessary:

1. Grinding the thick glass plate with fine flour emery, or after once being used, removing the old film either with potash or soda lye, washing, grinding and scrubbing, afterwards drying the surface.

2. Coating with a mixture of dextrine and silicate of soda, and drying this coating, usually called the substratum. When this substratum is dry the plate is rinsed under the tap to get rid of the free silicate, and again dried.

3. The plate is placed in the oven, carefully levelled, and warmed to 120° Fah.

4. The warmed plate is coated with a measured quantity of bichromated gelatine, returned to the oven, and the film dried at a temperature of 125° Fah.

The Substratum (2).—The operation of grinding has already been described. The plate, when dry, is coated with a mixture of

Dextrine	1 ounce
Water	10 ounces
Silicate of soda	½ ounce

The two are mixed and filtered through fine swansdown. If the mixture, after standing a few hours, assumes a jelly form, the proportion of silicate is too great, and a fresh lot must be mixed with less silicate. The mixture will keep for days, but must always be filtered just before use, as, no matter how often it has been passed through the filter

it will, after standing an hour or two, again require filtering on account of its constantly throwing down a deposit.

When the plate is coated with the mixture of dextrine and silicate it is stood on end to dry, or placed on a rack. The coating must be dried in a warm room, and if there is any difficulty in getting a good substratum, on account of the want of a dry place, the plates must be dried in the oven—not necessarily in a horizontal position—as the glutinous matter must be coagulated, and this can only be done when the mixture is thoroughly dry. The silicate being somewhat deliquescent, a certain amount of heat is requisite to obtain this coagulation.

When the coating is quite dry the plate is rinsed under the tap for about a minute, this rinsing being necessary to get rid of the free silicate. The plate is again dried, this time either by heat or spontaneously as may be most convenient.

A plate, after the coating of silicate and dextrine is dry, must be rinsed at once, as the film, if left, will soon be rotted by the free silicate; but when dry, after rinsing off the free silicate, it can be kept any length of time without special precautions being necessary for storage.

The silicate of soda of commerce is, as regards its consistency, very variable; sometimes it is supplied in quite a fluid state, like glycerine, at others it is so thick as to flow with very great difficulty. When it is thick it should be diluted with water until of the consistency of glycerine and then used as per formula given above; or if not diluted it must be used in proportions to be ascertained by experiments. Here judgment is required, as an exact formula is almost impossible. That given above refers to a consistency of silicate about that of glycerine. Silicate of soda in a solid state is not usable.

Instead of using dextrine for the preliminary coating, or substratum, albumen can be substituted, the formula for this being

Whites of	5 eggs
Water	10 ounces
Silicate of soda	1 ounce

Separate the whites from the yolks and beat; add the water, beat ; add the silicate, and again beat up. This is used exactly as directed for the other mixture. Dried albumen can be used instead of fresh, in the proportion of 100 grains for each egg. Gum arabic, gum tragacanth, separately or together, mixed with sugar, glucose, &c., or along with silicate of soda or potash, will give a good substratum for collotype.

The Sensitive Mixture.—Weigh out 1 ounce of middle hard gelatine (or half of each, hard and soft), put into a clean jug or jar, add 10 ounces of clean water, and let the gelatine soak until soft ; an occasional stir up with a clean glass rod facilitating this operation. When the gelatine is perfectly soft place the jar or jug into a pan of cold water, placing the pan on the gas stove ; as the water in the pan warms up the gelatine will dissolve, and should be stirred to facilitate solution and mixture with the water. Do not allow the temperature of water in the pan to rise *higher than* 120° *Fah.* When the gelatine is all dissolved add 120 grains of potassium bichromate in fine powder, a little at a time, and stir vigorously with a glass rod to aid dissolution. Now place another clean jug into the pan, previously warming it with hot water, and into this jug filter (either through paper or swansdown), the above mixture; this should be done quite an hour before wanted for coating, so as to allow time for air bubbles to disperse, keeping the water in outer pan (in which both vessels used are standing) at 120° Fah., and no hotter. So long as the gelatine mixture is kept fluid (and at the above temperature), it can be used for coating plates at any time ; but if it is allowed to cool it is best not re-melted, as the resulting collotype film will be too hard to yield good prints.

Coating the Plates.—Whilst the above sensitive mixture is being prepared the silicated plates should be in the oven, levelled, and heated up to about 120° Fah. For coating with the sensitive mixture, the plates must be measured, the superficial area calculated, and an allowance made of four minims per square inch. Thus, presuming that the two plates to be coated measure each 12 inches by 10 inches,

the area will be 120 inches; multiply 120 by 4 (*i.e.*, four minims per square inch). gives 480 minims; divide this by 60 (*i.e.*, the number of minims in a dram) and we get eight drams; so for each of the two plates, 12 × 10, we require eight fluid drams.

The sensitive mixture, after filtration and standing a little time, is carefully measured out in a clean *warm* graduate, the warmed plate balanced on the hand, then the whole of the measured quantity poured at once in the centre of plate. Get rid of graduate, and with the little finger crooked, guide the gelatine mixture carefully and evenly to the sides, without spilling any of it; when this is accomplished, return the plate to its levelling screws, coat the other plate in the same manner and with same quantity, return that to the levelling screws, close the oven and leave till dry, which at 120° Fah. will require about one hour.

During the time these coated plates are drying, great care must be taken that no vibration of floor takes place, or the plates will be useless; neither should the temperature of interior of oven exceed 130° Fah. When the plates are dry the surface should be a bright matt; if smooth and shiny the gelatine is too hard; if dull, the gelatine is too soft. In the first case there will be a danger of glazed shadows yielding sooty prints; in the second, the paper will stick to the film during printing. Hard gelatine can be made workable by the addition of a little *liquor ammoniæ* before the mixture is filtered. Soft gelatine is much improved by being kept in the mixture for three or four hours before coating.

For machine printing another method of preparation is advised, viz., to give two coatings, the first one of two minims per square inch, dry this at 105° Fah. (requires little over forty minutes), then apply another coating of four minims per square inch, and dry at 120° Fah.; this procedure gives a good ink-holding grain, and at the same time allows the lights, &c., to absorb more glycerine, which allows of longer printing runs, and gives brighter prints.

If, instead of getting the six minims per square

inch of surface at two coatings, an attempt is made to get the thick film at one drying, the result will be a wavy film, useless for printing from, even if the grain is not too coarse for good work.

For long runs on machine a good plan is to omit one quarter of the water given in the formula, and substitute for it the same quantity of the following :

Methylated alcohol	1 pint
Balsam of Tolu	1 dram

This is warmed and added a little at a time (stirring vigorously all the time) directly after the bichromate of potassium has been added and dissolved ; the other operations are as already directed. The addition of the Tolu in alcohol toughens (does not harden) the gelatine, and reduces the relief.

The film of the collotype plate when dry is sensitive to light, and care must be taken to shield it from light, and also from damp, to which it is equally sensitive. Directly the films are dry the heating supply must be discontinued, the plates allowed to cool gradually, and just before they are cold they must be placed face to face, with films touching, this being the only method of keeping them in good condition more than an hour or two.

Exposure to Light.—When a printing frame without a back is used the progress of printing can be seen without any trouble The whole of the detail should be seen through the back, as unless the image is well exposed a good printing block cannot be expected. An actinometer is very useful with which to time the exposure to light. Perhaps the best form is a quarter-plate negative with a piece of paper under it, floated upon the following mixture :

Gelatine	2 ounces
Water	20 ounces
Bichromate of potash	¼ ounce

With such an actinometer the progress of the plate can be very easily gauged. Always give a full exposure, as with an over-exposed film it is still possible to get prints, but with one under-exposed it is not.

Washing out the Bichromate.—When the exposure under the negative is complete, the plate is immersed in clean cold water until the whole (or nearly) of the yellow colour of the film is washed out ; this can be done in a flat dish, changing the water occasionally. The best plan is to have an upright box with grooves, in which to slide the plates. Such a box should have a tap at the bottom, by which the water can be withdrawn to make room for the introduction of fresh. Washing in an upright box clears the film of bichromate with fewer changes of water and more rapidly than in a flat dish. When the plate is sufficiently washed it is put on edge to dry, and when the film is quite dry it is ready for the printer; but it cannot be printed from without being dried first, as so much water has been absorbed as to render the film soft, and also incapable of taking ink.

The Negative.—The negative is the principal item in the production of a good collotype print ; it can be made by any process, and upon any kind of dry plate. The requirements are, a soft delicate negative with a slight indication of over exposure, so as to keep the shadows from being filled up with ink. Negatives for collotype require to be reversed ; and, as it is always difficult to make negatives from nature exactly the size wanted, it is generally more convenient to reproduce. Especially is this the case when two or more prints are to be made upon one sheet, as then the negatives must be flexible in order to get them all of equal thickness ; in fact, unless patent plate glass be used to carry the negative films, flexible negatives are always desirable.

In the reproduction of negatives a transparency should be used, and this transparency is best when made by the Carbon process, there being no other method of making transparencies, either in cost or in quality, that can compete with this process. When the very best results are necessary, the transparencies *must* be so made, as no matter how skilful an operator may be he cannot produce transparencies in any other way that can for a moment compare with those made by the Carbon process. In

addition to other advantages which the process of reproducing the negative has, there is the scope given for improvement upon the original; from a weak original a bold vigorous negative can be made, and from a harsh negative a soft one. Carbon transparencies are easily intensified by flooding with a strong solution of permanganate of potash; and when the original negative is dense and harsh, the transparency is made upon ordinary carbon tissue, instead of upon transparency tissue. When an original negative is used, should any accident befall it loss and inconvenience will be caused; but when a reproduced negative is broken or scratched, another can be made at once.

Flexible Negatives on Wet Collodion.—In using the wet collodion process—and it cannot be beaten in economy or quality—the negatives are made upon polished plates, and after development (and washing) are intensified with

No. 1.—Pyrogallic acid	60 grains
Citric acid	30 grains
Water	1 ounce
No. 2.—Nitrate of silver	30 grains
Water	1 ounce

After the developer is thoroughly washed away, sufficient of No. 1 to well cover the plate is put into a small cup, and to this 10 or 20 drops of No. 2 are added; the mixture is then poured on and off the plate until the requisite density is attained. If any portions require a little extra density, this can be accomplished by repeatedly pouring the solution on those portions, which are thus built up in density. If this is done carefully, no trace of such local intensification will be apparent.

All reproductions from indifferent originals should be done by the wet process, because this process lends itself so readily to the skill of the operator, who can easily produce an improved result. When the negative is intensified it is washed, then fixed, and again washed and dried. Now it can be stripped in two ways: first, it is carefully levelled, then covered with

Gelatine	5 ounces
Water	20 ounces
Sugar	1½ ounces

For a plate $8\frac{1}{2} \times 6\frac{1}{2}$, 3 ounces of the above will be required; the gelatine should be carefully strained through muslin, and should not be hotter than 110° F. when poured upon the negative. When the negative is coated the gelatine is allowed to set, then the negative can be put on a rack and allowed to dry in a warm current of air, and when dry the film is stripped off. In coating a batch of negatives that are intended to be printed all together, care must be taken that each negative is level, and also that each has exactly the same quantity of gelatine upon it.

Another way, and in many respects a more satisfactory one, is as follows :—Procure a large sheet of plate glass, quite free from scratches, clean this with a little spirits of wine, then level carefully, and coat with

Gelatine	7 ounces
Water	20 ounces
Sugar	2 ounces
Sulphuric acid	1 dram

Add the sulphuric acid when the gelatine is melted, then strain through muslin, and pour upon the plate (24 × 20). Commence pouring at the edges, and gradually work into the centre, touching any air bells that form with a piece of sharp wood or a quill tooth-pick. When the gelatine has set, the plate can be stood on one side until the film is quite dry, which will be, on an average, in three days. When dry, run a knife blade between the glass plate and the gelatine film all round the edges, and the film can be lifted off. In this condition it is kept and cut up into sizes as required. The surface of the glass plate can be ground before coating with the gelatine, and the film when taken off will be matt on one side.

To use these films, or skins, cut to the size of the negative to be stripped from the glass plate, soak it in cold water for three minutes, wet the film of the negative under tap, then slide into water under the skin, adjust the skin in its position over the negative, then remove the negative with skin adhering to film, put on a bench, cover with a sheet of indiarubber cloth, and squeegee vigorously, using a scraper squeegee (not a roller). The plate is then put

away to dry. When the skin is quite dry it can be stripped away from the glass, carrying the collodion film with it.

If the negative be required in a hurry, directly the skin has been squeegeed down it can be lifted with the collodion film adhering to it, turned round, and replaced on the glass, the collodion film on top. Soak it in methylated spirits for a few minutes, and it may then be dried at the fire.

For negatives suitable for collotype the chemicals must be in first-class order, the collodion ripe, the silver bath in good condition and of full strength, the developer old and clean, the plates well polished and of good glass (old dry-plate glass must not be used); in fact, everything must be working in complete harmony. Then the negatives will be very satisfactory, the collotype plates from them will work well in press or machine, and the prints run the best silver or platinum prints marvellously close.

On Dry Plates or Films.—When dry plates are used it is necessary to strip the films—an operation simple enough, but one which has too much risk for commercial purposes. To strip an ordinary gelatine negative it should be well alumed, washed and dried; then the operations are:

1. Clean the back and edges carefully, as if pieces of the gelatine film are left on the back or the edges they become detached, and are apt to lodge on an important part of the negative during the operation.

2. Level carefully; for this purpose place the negative on a levelling stand, or upon three wedges, and use a good, long spirit level.

3. Cover with plain collodion, pouring on nearly as much as the plate will hold without running off; make the collodion flow right up to the edges and corners. The collodion is to prevent the film from frilling, or stretching, and if not sufficiently thick the gelatine film will curl, and be difficult to handle when detached from the glass plate. The film of collodion must be allowed to set thoroughly before the plate is disturbed.

4. When the collodion film is firm to the touch, the plate is immersed in a dish of clean cold water, until the

ether and alcohol are washed away, the water flowing over the film smoothly when they are removed instead of being repelled as it was when first immersed.

5. The plate is immersed in an ebonite dish containing :

Water	80 ounces
Sodium fluoride	2 to 4 ounces
Hydrochloric acid	1 dram

Rock the dish gently until the film commences to lift at the edges, then remove, and wash under the tap. Commercial fluoric acid varies greatly in strength, but the soluble fluorides are constant and are much more easily and safely handled. The acid need not be added till the last moment, so that the solution can be kept ready for use.

6. Place a plate which has been coated with gelatine (and dried) in a dish of water, coated side up ; take the plate (5), still carrying the film, and put it (film side down) upon the surface of the water ; the film will leave the glass and float upon the water ; put the glass plate away, lift up the glass plate in the dish, gently adjust the film upon it, remove plate and film from the dish, squeegee the film down, soak in spirits of wine and put on a rack to dry.

This is for a single negative. If a number of negatives are to be put upon one plate, mark out the positions of each upon a sheet of paper ; lay the glass plate coated with gelatine upon this paper, and, having floated the films (one at a time) off the original glass plate, lay each in position as required ; cover the whole with a smooth sheet of indiarubber cloth, and squeegee them into contact with the gelatine ; soak in spirit and allow to dry.

The plates to which these films are finally attached are coated with :

Gelatine	2 ounces
Water	20 ounces
Chrome alum	20 grains

dissolving the chrome alum in the water before soaking the gelatine therein. When the gelatine is dissolved add 2 drams of acetic acid, stir well, filter through muslin, and flow over the clean glass plate, drying the film by placing the plate on a rack. These plates when coated may be stored till wanted, as the film keeps any length of time.

To make flexible negatives, clean a glass plate, coat with a thin film of plain collodion (Mawson's Enamel Collodion answers well), and let this dry. The plate, when cleaned, is held on a pneumatic holder, the collodion poured on, the surplus being returned to the bottle.

When the film of collodion is dry the plate is levelled and coated with the gelatine solution given above for coating collodion negatives, allowing 5 ounces of solution for each plate 12 × 10, larger or smaller sizes in proportion. When the gelatine has set, the film may be allowed to get dry, or the stripped films may be mounted upon them at once and dried afterwards, but do not use spirits of wine to facilitate this drying. When this method is practised the compound film requires two or three days to dry, but if the gelatine film is allowed to get dry before mounting the negative upon it, the compound film will dry in a few hours. When dry the compound film can be easily detached from the glass plate. Dry plates are now in the market specially prepared for stripping. They are manipulated exactly in the same way as are ordinary plates until dry, then they are either levelled and covered with gelatine, as above, or a gelatine skin after being soaked in cold water is squeegeed in contact with it, and when dry the two films are stripped off the glass plate.

For developing gelatine negatives for collotype, ortol is the best reducer; it gives a negative which has all the vigour of a pyro negative without its harshness, or tendency to yellow stain, which for silver printing may be useful sometimes, but for collotype is a great drawback. The following formula is good:

No. 1.—Ortol	1 ounce
Meta bisulphite of potass	½ ounce
Water	60 ounces
No. 2.—Washing soda	3 ounces
Water	20 ounces

For use, take equal parts of No. 1 and No. 2. Develop all negatives by the factorial method, which gives perfect control, and enables the operator to get all his negatives alike, a great desideratum when two or more negatives are

to be combined upon one sheet. For the developer given above the factor is 10; the normal time of appearance, 30 seconds; time for complete development, five minutes; temperature, 65° Fah.

After development, fix in ordinary hyposulphite fixing bath, wash well, then soak in strong solution of alum slightly acidified with hydrochloric acid, again wash, and dry.

Instead of the alum, 1 ounce of formalin mixed with 20 ounces of water may be substituted, and it will be found to give a tougher film for stripping.

When it is desired to print from a number of negatives on one plate, the thick celluloid films will be found very handy; but the ordinary thin or roll films are not recommended, as it is frequently difficult to get proper contact on the collotype plate.

When original negatives of subjects for reproduction in collotype cannot be obtained, or when such negatives are not suitable for the purpose, prints should be made by the method calculated to do the most justice to the negative. From flat or thin negatives, prints may be made upon gaslight, or slow contact bromide paper with glossy surface; from other negatives good well-toned silver prints give the best results. Whichever method is adopted, the prints may have the title written, defects remedied with colour, and in cases of very bare foregrounds, suitable figures, &c., may be introduced. The requisite number of such prints, of as even a tone all through as is possible, are then mounted together and a large direct negative made, using a prism or mirror, so as to get the negative reversed.

All negatives, single or multiple, should have the edges (that are required to be white in print) masked with thin tinfoil. Paper does not answer for this purpose, first because it is impossible to obtain paper thin enough (and opaque) to allow of the necessary contact with the collotype film; secondly, paper will attract moisture, and moisture has the same effect as light upon the collotype film. Hence, if paper be used, the margins cannot be kept clean, but will have an objectionable tint. Tinfoil, on the other

hand, is perfectly opaque, thin enough to allow of absolute contact between negative and collotype plate, and, being impervious to moisture, the margins are kept quite dry, and consequently print perfectly white.

CHAPTER III.

PRESSES, &c., FOR PRINTING FROM THE COLLOTYPE PLATE.

PRINTING from collotype plates is done by hand press or machine. For hand-printing there are specially made

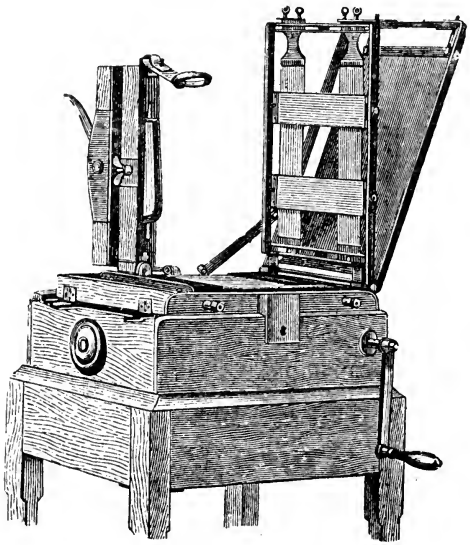


FIG. 24.—COLLOTYPE PRESS.

presses, or lithographic and typographic presses may be used. The specially made presses require no comment, as they are fitted for the work in a very complete manner.

Lithographic Presses.—These require a bed for the glass plate, in the shape of a double-faced stone a little larger than the collotype plate; under the tympan (of leather or brass) is fitted a thin smooth blanket. If the tympan is of leather the scraper will need no alteration, but with a brass tympan the scraper must be shod with leather, fixing it at the ends, not along the sides of the scraper. Good heavy strap leather is best for this purpose. Various sized scrapers should be provided, so that one can be used a little larger than the picture to be printed.

Typographic Presses.—These are prepared by bedding a thick sheet of plate glass, of the same size as the collotype plate, in the centre of the bed, with a little thin varnish. Upon this sheet of plate glass a sheet of wet blotting-paper serves as the bed of the collotype plate. If the plate glass bed be ½ inch in thickness and the collotype plate the same, no alteration will be required in the platen, as a little loose backing will give the necessary pressure. For a typographic press a good plan is to cement a piece of blanket to a sheet of millboard, then the blanket can be much more easily handled than if loose, and extra backing sheets can be put on when required. The tympan must be smooth, not filled in behind with uneven backing, or the plate will break. Of the two types of typographic presses the Columbian is better than the Albion, being less liable to cause fracture. A large press will also work better than a small one.

The Rollers.—Two rollers are required, one of leather, the other of gelatine and glycerine. The leather roller may either be a nap or black lithographic roller, or a colour roller (lithographic). The first has the grain of the leather inside, and flesh side out; the other the grain outside. The nap roller requires greater care and time in preparing it for work; but when once in good condition remains so longer, and is more easily kept in working order. The colour roller can be got ready for use in a day or two, but requires constant attention to keep it in good working condition. A new nap roller is marked on the handle in the direction towards which the nap sets. To prepare it

for use, hold it in front of a fire, and rub lard into it until the skin has soaked in as much as it can do. When the lard is cold, scrape off, and roll up in strong litho varnish. This will bring out the nap. Roll up in this varnish at intervals for a couple of days; scrape off the varnish, and roll up in middle varnish, and gradually thin this down for two days; scrape and roll up in thin ink, gradually increasing the consistency of the ink until the roller is ready for use. After this, if it is possible, the roller should have a fortnight's work by a lithographer, then it will be in prime condition.

A colour roller is soaked with lard, scraped, rolled up for an hour or two in middle varnish, scraped, rolled up in ink, and is ready for use in two days. The best French or German skins should be used for collotype printing, English skins being too rough. Leather rollers are cleared of old ink by scraping with a blunt knife, the scraping being done towards the body, and with the nap. A pair of leather handles to cover the wooden handles or roller whilst using must be provided.

The other roller is of the ordinary typographic pattern, the composition being specially hard. Only a few firms supply these rollers, so special enquiries must be made before purchase as to suitability for the purpose. A good composition roller for collotype should be soft yet firm, and not tacky.

Inks.—Inks for collotype must be of the best. There are plenty in the market of all colours and tints; and if the printer has by him black, bronze blue, indigo, maroon, sepia, venetian red, and middle chrome, any taste or subject can be suited.

Litho Varnish.—All inks will require more or less thinning down to working consistency; this is done with lithographic varnish, which is oil boiled and burnt to get rid of the fat. Lithographic varnishes are of two kinds, viz., ordinary and tint, the first being of a brownish colour, and the last much lighter. For collotype "thin tint" or "middle tint" varnish is required. In very cold weather, or when printing upon enamel paper that has not been

coated very long, cocoanut oil or lard may be used instead of varnish. To mix the ink and varnish a strong knife is required, a butcher's sheath knife being very good for the purpose.

Paper.—Collotype prints can be made upon any kind of good woven paper. Very soft or laid papers are not suitable. As in every other illustrative method, the best results are obtained upon coated or enamelled papers, of which class there are many in the market, the coating in some being very thin, in others quite thick. The former are used extensively by letterpress printers, the latter being what has long been known as "dull enamel" or chromo paper. When the last is used a sample must be chosen with a smooth back, the rough backed paper not being easy to print upon. All coated papers require age to give stability to the enamel, and where possible should be bought in bulk and stored. Collotype prints upon good plate or other rough-surface paper are always appreciated; in fact, all tastes can be suited in collotype printing in the matter of the paper upon which to make the print.

Masking the Margin.—In order to print with a clean margin it is necessary to use a mask, which is placed in position for each print. On the machine this is done automatically, a special piece of apparatus being provided for the purpose. For printing on the hand press a light frame of iron is required a little larger than the plate, with a sheet of parchment paper stretched (à la drum-head) over it, and then coated with gold size, to prevent the paper from absorbing moisture from the plate and causing it to stretch. A mask frame for plates 15 × 12 should measure inside $15\frac{1}{8} \times 12\frac{1}{8}$, and be made of $\frac{1}{4}$ inch rod iron, round or square. To this the parchment paper is cemented at the edges all round, and when the edges are dry the paper should be tight and smooth; the inside is then coated with the gold size, thinning down with turpentine. When the gold size is dry the mask is ready for use. Special collotype presses are, of course, fitted with proper masking arrangement.

Collotype for Amateurs.—By using plates of ordinary thickness, and grinding and preparing them as directed in Chapters I and II of this part, amateurs may dispense with the bulky and expensive presses used by professional collotypists, substituting one of the domestic wringers with indiarubber rollers, which answers admirably as a press for amateur workers.

Instead of using a leather lithographic roller, procure two small letterpress rollers, such as are sold by dealers in small letterpress printing presses, one roller to be of soft composition, the other hard. If any difficulty be found in obtaining the harder one, a soft roller soaked in a solution of alum 1 ounce, water 10 ounces, for half an hour, then dried, will answer the purpose.

An improved method of the Sinop process has just been introduced, and the collographic method will be found very adaptable to amateur requirements, using either a copying press for the printing or the wringing machine with rubber rollers.

CHAPTER IV.

PRINTING FROM THE COLLOTYPE ON THE HAND PRESS.

First of all it is essential to get the picture upon the plate into condition for printing. As it now is, with the film dry, a roller charged with ink would blacken it all over without showing the slightest sign of an image; but if the film be moistened with water, the gelatine will absorb water in inverse proportion to the action of light—*i.e.*, where the light has acted most upon the film when under the negative, no water can be absorbed because the light has hardened the gelatine to such an extent as to render the gelatine incapable of absorption, and where the gelatine film has been quite protected from the light the gelatine will absorb its full quantum of moisture. The result is, that in the first case the gelatine will take ink, in the latter it cannot. Thus we get, respectively, the blacks and whites of the picture, the half tones being rendered by the gelatine having been acted upon by light in due gradation from light to dark. From this it will be seen that before prints can be made from the plate it will be necessary to moisten the film, so that when an ink-charged roller is passed over, the ink will take in those proportions necessary to form a picture. This moistening is called "etching"—a misnomer, but one that has so universal an acceptance that it is quite impossible to change it. Merely soaking in water is sufficient to enable printing to go on; but when water alone is used it is necessary to damp the film after each print, which entails a lot of useless labour, does not at all improve the resulting picture, and risks the film

being scratched in the course of the frequent wiping which is necessary. If glycerine be mixed with the water, from ten to thirty prints can be made after each time of damping. To prepare a plate for printing it is first of all carefully cleaned at the back from any adherent gelatine, &c., and then placed on a levelling stand. The surface is now covered with sufficient of the following etcher :

Glycerine	5 ounces
Water	15 ounces

This is allowed to remain upon the film for about half an

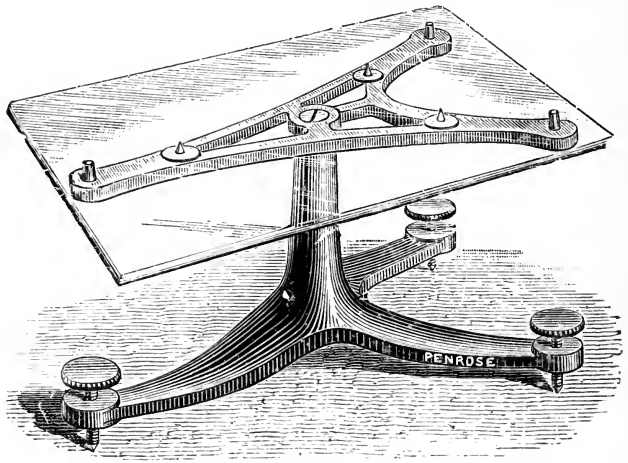


FIG. 25.—LEVELLING STAND FOR COLLOTYPE.

hour, after which the etcher is soaked up with a sponge, and returned to the bottle or jar. A sheet of clean blotting or other white paper having been put on the bed of the press, the plate is laid upon it, and with a soft cloth the surface is carefully dabbed dry.

While the plate is etching, the roller should be scraped, the inking slab cleaned with turpentine and a rag, the composition roller washed with turpentine, the ink mixed, and the leather roller charged with ink. When the plate has been laid on the press, and the surface been dabbed

dry, the leather roller is at once passed over, and after a few seconds the image will take ink, and gradually gain in brilliancy. Roll carefully until the image is perfect in its details; lay down the leather roller, pass the composition roller over the inking slab, then over the plate. This will clear up the image, and smooth down any irregularity left by the rougher leather roller. Now take a print, being careful not to use too great a pressure, as the glass plate is easily broken.

The first print is seldom entirely satisfactory. If the image is mottled, the pressure has not been sufficient, and for the next print must be made heavier—this being done in lithographic and collographic presses by means of the screw on the head above the scraper; on a typographic press, by means of a screw above the platen or the lever. If the whites are degraded, the ink is too thin; in this case the leather roller must be scraped, the slab cleaned, and the ink made stiffer by the addition of fresh ink from the tin, which must be well worked up with the palette knife. If the half-tones are blocked, wash out the ink with turpentine, cleaning this off with water; then add a little ammonia to the etcher (say 1 dram to the 20 ounces), cover the film with this, and allow to act for fifteen minutes, then soak off, dab dry, and ink up again. When ready for printing, ink up the image roughly, put on the mask frame, run the fingers round the margin of picture, so as to get an impression of image upon the parchment paper, of the exact outline. Next remove the mask, and with a straight edge and a sharp knife cut out an opening in the parchment paper, about $\frac{1}{16}$ inch larger all round than the picture. Now take a sheet of the paper to be printed upon, and measure it carefully, so as to get the image in the centre, and mark on the outside of the mask thus ⌐ — with lead pencil. These marks are to show where the paper has to be laid in order to get the image in the centre of the paper each time.

The cutting out the mask should be done on a sheet of glass, or on smooth metal, as any punctures or tearing of the opening will spoil that mask.

Dirty margins can be remedied by painting over with a weak solution of oxgall, or of caustic potash, but in hand-printing from carefully-prepared plates these dodges are seldom necessary. If the collotype plate be allowed to get damp at any time between drying and washing out the bichromate, the margins are apt to print dirty, and the whites also be degraded; then the use of oxgall will be necessary, and probably also the caustic potash. But the best plan is to rely upon the addition of ammonia to the etching solution to obtain the requisite brightness; and if this, after a prolonged soaking, is not sufficient, it is advisable to try another plate, and take more care over its manipulation. Damp is about the only thing a collotype plate is spoilt by, if the formula as given is properly carried out.

When a plate refuses to take ink at all, it has had too long an etch, and should be either allowed to stand a short time, or else one or two dummy prints be made, so as to soak up a little of the moisture standing on the plate, the latter being the best remedy for over-etching. The portions of the image that take ink too freely for pictorial effect should be etched by themselves, either by painting over the etcher with a brush, or blowing with a pointed glass tube. In fact, a careful printer can, by the exercise of judgment, obtain good results from any kind of plate.

When the plate is in good working order, it is inked up after every impression until a slight deterioration of the whites is observed. Then it is covered with the etcher for a few minutes; this is soaked off with a sponge, the surface dabbed dry with a cloth, and the printing resumed. At first this will be required after each ten or twelve prints, but afterwards, as the surface gets softer, as many as twenty or thirty may be made between each etching.

On the hand press about 500 prints will be the maximum number that a plate will yield; and as the trouble involved in making a fresh plate is so small, it is not worth while to produce indifferent prints from a worn-out plate, but to have a fresh one each day.

If the film comes away from the plate during the opera-

tion of rolling up, the substratum is at fault, or the plate has not been clean, or the substratum was rinsed before being quite dry, or the proportion of silicate of soda is not sufficient. Too great attention cannot be paid to the substratum stage, as unless this is all right the film is sure to come away when being printed from.

If the prints have a mottled appearance in the whites and half-tones the coating of gelatine is much too thick; the film is also too thick if an inordinate amount of pressure is requisite in order to get the ink out of the deepest black. The first fault cannot be remedied in that plate, but the last will disappear after a few pulls.

CHAPTER V.

PRINTING FROM COLLOTYPE PLATE ON MACHINE.

The Machine.—A collotype machine is an elaborated lithographic machine, being fitted with two sets of inking rollers—one set of leather behind the cylinder, and a set of gelatine in front. There are no rollers for damping, this

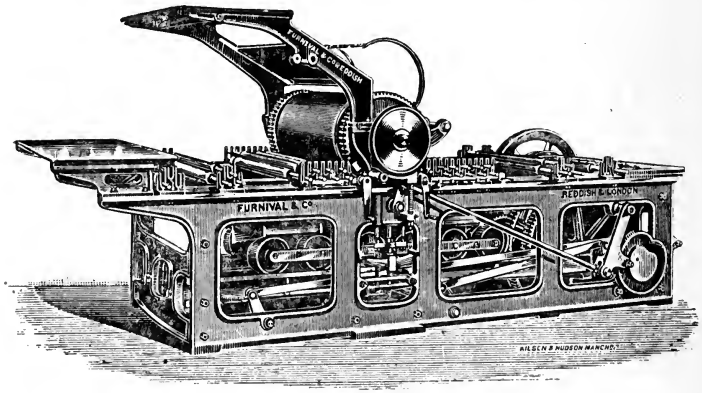


FIG. 26.—COLLOTYPE MACHINE.

operation being effected by an occasional stoppage of the machine, when the plate is damped, or etched, by being covered with a mixture of glycerine, water and ammonia.

A collotype machine is usually fitted with a mask frame, but it is very seldom used nowadays, as a skilful printer

can, *when he has a good plate*, so adjust his backing-sheet as to ensure clean margins without any mask.

A few years ago none but foreign collotype machines were to be had, but now there are several English firms who supply them.

Etching the Plate.—Before the collotype plate can be put on the machine it must be etched. To do this, place the plate upon a levelling stand, and cover all over with the following solution :

Glycerine	1 ounce
Water	5 ounces
Ammonia	from 1 ounce to 5 ounces, according to plate.

The glycerine and water soaks into the film, and enables the whites to reject the ink. The ammonia opens out the grain in the shadows, and must be used in greater or less proportions, according as the shadows are hard or soft.

Making-Ready.—The glass plates for printing at machine may be bevelled or not.

The preparation of the plates is exactly the same as for hand press, but the image is exposed on the edge of the plate about 1 inch or 1½ inches, or thereabouts, according to circumstances. If the job is to be printed on paper with a broad margin, the picture may be still further on the plate. The object of this is to keep the grippers from striking the edge of the plate, although on a good machine, providing the backing-sheet is of the correct thickness, the grippers may roll over the plates without danger of breakage. This is arranged by the grippers working on a bevel on the edge of the cylinder, thus bringing them below its circumference.

Presuming that a plate is ready etched for printing on machine, the first proceeding is to make the backing-sheet. Several pieces of thick or thin blotting-paper are taken, of the required thickness, gummed together along one edge, and feather-edged. The size of the picture about to be printed is measured off from side to side, allowing ⅛ inch more at each side ; then mark off from front to back, and allow an inch or so larger—*i.e.*, supposing the picture to be

11 × 9, the backing-sheet would be $11\frac{1}{4}$ × 10. Bevel the edges all round, and the backing-sheet is complete.

At some houses the preparations are of such a sticky nature that it is necessary to make the backing-sheet the exact size of the work.

In either case, the backing-sheet is stuck on the cylinder with glue or dextrine, and the distance from gripper-layers to base-line of work carefully measured to correspond with the exact margin required on the prints.

The blanket—which is usually either glazed waterproof or rubber—is now adjusted and fastened up, and the cylinder is complete.

Assuming that the machine has been washed up, the rollers and riders are placed in position, ink is applied to the duct-roller, and the machine is run to distribute it thoroughly on the rollers and tables for a few minutes. The bed is next carefully cleaned, and a piece of white paper placed in position on the bed against the ledge provided.

Now carefully clean the back of the plate, and place it on the white paper. Then fasten with the screws and plates provided.

A gripper-gauge is provided with every machine, and it is placed from side to side of the machine, resting on the racks. One of the teeth on each side will be found marked to correspond with the grippers, the gauge being adjusted to these ; and the distance from it to the base-line of work is measured the same distance as the backing-sheet was from the gripper. This is done by moving the bed by means of the screws provided for that purpose.

The same gauge on both English and German machines is also used to adjust the pressure. For this purpose it is placed on edge across the centre of the plate, and rested on the racks at the sides. The bed is then raised or lowered until, by testing with a piece of paper, the plate just touches the gauge, and is fairly level. It will, however, be found that this is not sufficiently high to correspond with the cylinder printing circumference. It is only a safeguard in making ready when changing plates of different thick-

nesses. A cylinder gauge is now supplied for the height of packing on the cylinder.

Now, after seeing that all is clear and everything is in correct position (no spanners on the bed and your whiskers out of the way), the word is given to the layer-on to start the machine ; this he does after placing in the grippers a piece of white paper the size of the job. When the cylinder has made one revolution the machine is stopped, and on examination it will be found that there is no impression. So a turn of the pressure wheels at end of machine will be necessary, and must be repeated after every trial revolution of the cylinder until the work is sharp from end to end and the impression solid.

If the plate is etched enough the job may now be proceeded with, and if any trouble is experienced in keeping the gripper edge and margin clean it may be treated with ox-gall, or a weak solution of cyanide of potassium.

But if the preparation is of the best no trouble is experienced in this way ; and consequently, with the backing-sheet carefully made, no mask or frisket of any kind is required on the cylinder. With some preparations it is impossible to work without one, and for this purpose it is usual for the machine to be supplied with a circular frame, which fits in grooves round the cylinder. Two strips of zinc are fastened from side to side, and two from front to back ; this forms a square in the centre, which can be adjusted nearly to the size of work and feather-edged with tracing paper more exactly. The backing-sheet will also have to be cut the exact size of work.

It is usual to start the machine by mixing the ink rather stiff for the leather rollers, and mixing a little thinner for the gelatine rollers.

Good plates will work without any further application of thin ink to the gelatine rollers. It is only intended to give them a start as they take a lot from the other slab.

The plate is etched and damped with a mixture of glycerine and water, and ammonia of varied proportions, according to circumstances.

Normal mixture :—Equal parts of glycerine and water, and one-tenth part of ammonia.

CHAPTER VI.

COLLOTYPE GRAIN.

THIS grain is an essential part of the collotype process and upon it depends the quality of the print; if the grain is too fine, sufficient ink to make a picture cannot be put on the film. If, on the other hand, the grain is coarse, the picture is also coarse. In the two illustrations (micro photographs) the normal grain, and that necessary for transfer to stone, are shown; the first is obtained by coating the plate with a 10 per cent. mixture of gelatine and water, in the proportion of four minims per square inch, bichromate of potash being the only other addition (Fig. 27). The coarser grain (Fig. 28) is obtained by coating the plate with four minims per square inch, of a 15 per cent. mixture of gelatine and water, with the addition (as well as bichromate of potash) of a small quantity of ferricyanide of potassium, in both cases drying the film at a temperature of about 120° F.

Should there be any vibration of the oven during this drying the film, the grain is broken up, and instead of having the beautiful regularity, as shown in the illustration, it will resemble a conglomeration of particles of sand or grit, the film will have a high relief, will take ink with great reluctance, and will be equally reluctant to part with it.

For collotype the best sensitiser to use with the gelatine is the potassium salt; the ammonium bichromate giving an entirely different grain, which only gives coarse muddy prints. The general formula for collotype films, may be put as 1 part gelatine to 10 of water, but every fresh

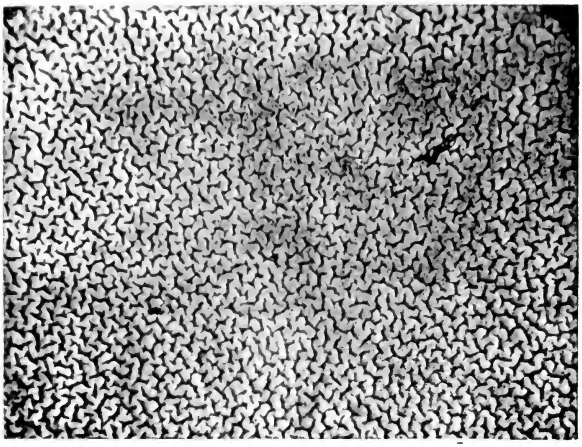


FIG. 27.—NORMAL GRAIN, 10 PER CENT. GELATINE.

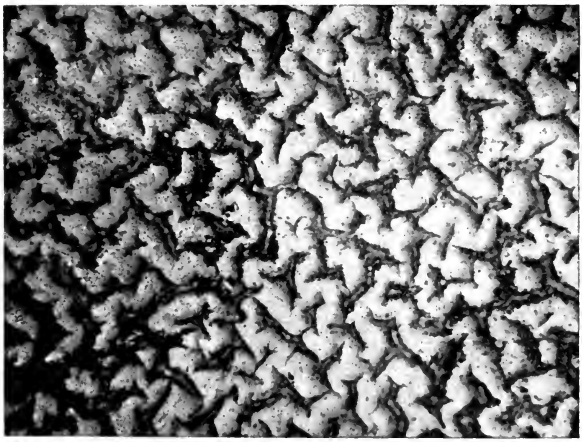


FIG. 28.—COARSE GRAIN, 15 PER CENT. GELATINE.

sample of gelatine will require testing before the final formula can be settled. Some gelatines at 1-10 will give too thick a film, or too coarse a grain, and will work best at 1 part of gelatine to 12 of water; other samples of gelatine at 1–10 will be too thin, and will give little or no grain, and will require the water reducing to 9, or perhaps 8 parts; all these points must be ascertained by actual experiment, in each case coating the plates with four, or at most five minims of the mixture to each square inch of surface coated.

With a gelatine requiring more or less water than 10 parts to 1, it might be thought that coating the plate with less or more than mixture would give the desired result, but such is not the case, because with a thin solution the film becomes wavy, and is useless, with a thick solution the grain is still coarse.

For half-tone transfers to stone, zinc or aluminium, there is no process which gives such good results as does the transfer from a collotype plate, but for this purpose we require a larger grain than is permissible in a collotype print, and this larger grain cannot be obtained by using a thicker film of a 10 per cent. mixture of gelatine and water, but it must be obtained by the addition of ferricyanide of potassium, or calcium chloride, or zinc chloride, or sodium chloride in a 15 per cent. mixture of gelatine and water.

No matter what the strength of the gelatine used, the amount of potassium bichromate added must never exceed 25 per cent. of the weight of gelatine, or it will crystallise out in drying.

Part VI.

PHOTO-MECHANICAL PLATES FOR THREE COLOUR PRINTING.

CHAPTER I.

TRICHROMATIC PRINTING.

TRICHROMATIC photography is the term applied to the production of photographic negatives from which coloured prints—either by means of half-tone blocks, collotype plates, or photo-lithography—are produced in three workings, the preparation of the selective negatives being in each case the same.

This process consists in making from nature, or from a painting, a series of three negatives. In one negative (the yellow), the blue and the red rays are non-existent; in another (the blue), the yellow and red are eliminated; and in the other (the red), the blue and yellow are missing. From these negatives either blocks, transfers or collotype plates are made, from which, when printed in its own colour of ink and superimposed, prints in colours and tones identical with the original are produced.

To make these negatives, that for the yellow printing plate is made through a blue-violet screen or filter, which only allows the blue and red rays to pass through. The red printing plate requires a green screen or filter, passing yellow and blue; a red screen or filter, absorbing yellow and red, being used to produce the blue printing plate.

Such, in a nutshell, is the theoretical process of trichromatic photography; and if the photographic plate could be impressed in the camera with the same monochromatic rendering of colour as we do, the above theory would be perfect in practice—but such is not the case. For instance, take yellow and blue; to the eye, the first

is light, the second dark. The photographic plate reverses this rendering, yellow being dark, blue light. Then, again, colours as we see them are not pure, and in the spectrum the colours merge one into the other, so that we cannot tell where one begins and the other leaves off. The ordinary photographic plate, whether wet collodion or gelatine emulsion, is far more sensitive to blue than to any other colour sensation ; and although there are methods whereby the sensitiveness to green, yellow and red sensations can be very greatly augmented, yet that of the blue is still the greatest, and this is the point which has prevented real progress in trichromatic photography.

Screens or filters theoretically correct can easily be made, but on account of the abnormal blue sensitiveness of the photographic plate such a set is practically useless ; therefore, in order to counteract this defect in theory, the screens must be adjusted to suit the particular method of working to be adopted.

If commercial gelatine dry plates are to be used, there are two systems of working, viz.: (*a*) with a different plate for each filter, *e.g.*, an ordinary photographic (*i.e.*, blue sensitive only) plate with the blue-violet screen for yellow printing plate, a plate sensitive to yellow and green with greenish yellow screen for red printing plate, and a red sensitive or panchromatic plate with red screen for blue printing plate ; (*b*) one plate to be used with each of the three filters, in which case the filters must have their absorption so adjusted as to counteract the differences between theoretical and actual sensitiveness.

A set of screens for the (*a*) system will not seem, to a visual inspection, any different to the set for the (*b*) system, but the differences are very marked in the path of the spectrum, and tricolour negatives made with the screens and sensitive plates interchanged would give marvellously different results.

As a mere matter of actual practice, the making of a set of screens is very simple, and quite within the capacity of any practical man ; but, as a question of economy and efficiency, the manufacture is far better left with some one

who makes a speciality of it, simply because the making and adjustment of the screens is tedious and requires so much trouble and mess, which, when worked on a small scale, makes the game not worth the candle.

The requisite dyes are difficult to obtain, and our three-colour writers all seem to vie with each other as to who can bring out the more formulæ and methods of making the three screens. Then the glass must be of the right kind, the substance and colour must be right, or it will introduce an element of disturbance. Some dyes are soluble in spirit, and can be made up in collodion; but collodion varies, and so adjustments are upset. Again, other dyes are not soluble in spirit, then gelatine has to be used to carry the stain, and as no two samples of gelatine are alike, trouble again ensues.

Let the beginner make up his mind as to the system he intends to practise, then buy his screens adjusted for that method; time and money will be saved, and success will be far nearer. Von Hubl's book on "Three-Colour Photography," published by Penrose & Co., is the text-book on the subject, and can be recommended.

There are two methods of producing three-colour letterpress blocks, viz., the direct and indirect. In the first method the copy is placed upon a board capable of being rotated at different angles; the three negatives are then made through the ruled screen. This method can be worked with the gelatine dry-plate method, or with collodion emulsion, and it has the advantage of economy and saving time.

In the indirect method, the selective negatives are made without using a ruled screen; then from these negatives transparencies are made by contact upon gelatine dry plates, from which the grained negatives are made. This method is roundabout and tedious; it is also liable to introduce differences into the result. By the direct method the grained negatives are made at once, and a great saving of time is effected. The direct method can be worked with dry gelatine plates, or by the collodion emulsion process, the last being undoubtedly the best, because the points of

the ruled screen are so much more easily controlled in the collodion film than in a gelatine one; and, again, there is no difficulty in sensitising the emulsion for the spectrum, and to fit the colour filters, which cannot be so well done with gelatine plates.

After the negatives are made, the rest of the work is the same as for ordinary monochromic work, except, perhaps, that a great deal of practical skill is required in fine etching the block, so as, in some measure, to counteract the want of sympathy between the theoretical requirements of the process and the actual capabilities of the photographic plate.

Wheeler's Metzagraph screen gives very good results for half-tone photo litho, and it is quite easy to work. For tri-colour collotype, a little coarser grain is advisable than can be used for monochromic.

The screens or light filters may be liquid used in a tank, or dry—*i.e.*, glass plates coated with either gelatine or collodion stained in, or with the dye.

The liquid filters are admirable for experimental work, but for practical commercial work are not to be recommended, the trouble entailed in cleaning out the tank between each exposure being against its use. If it were possible to obtain three tanks exactly alike, this method might have advantages, but such a thing is not possible, unless at an enormous expense. The slightest difference in contour, in thickness of walls of cell, in colour of the glass —any of these would result in alteration of register of the three images, and consequent ruin to all chances of a successful superposition. Again, the liquid dye undergoes alteration, which cannot be detected, except in the spectrum, and that is fatal to their use.

Dry filters are made by coating patent plate glass with a 10 per cent. solution of fine white gelatine, allowing 6 minims of the gelatine solution to each square inch superficial of the surface to be coated when properly level; and when the film has set, the plates are put to dry somewhere free from dust. Six such plates are necessary for each set of three filters.

When the gelatine film is quite dry, the dye solutions are made up.

For the blue-violet filter, one coated plate is dyed in a solution of new blue aniline colour :

Water	100 c.cm
Alcohol	20 c.c
New blue (1 in 150 of water)	20 c.c
Acetic acid	5 drops

The operation of dyeing takes about ten minutes, after which the plate is rinsed under the tap for a minute or so, then put away to dry. The second plate for this (B.V.) filter is dyed in a similar bath with acid violet instead of the new blue.

For the green filter, the dye bath is made up of a strong solution of picric acid or of picrate of ammonia, the second plate for this filter being dyed in a bath of

Water	100 c.c
Alcohol	20 c.c
Malachite green (1 in 150 water)	25 c.c
Borax	½ gramme

For the red filter, use biebrick scarlet for the dye, with five drops of acetic acid, for one plate; and dye the other plate with methyl orange, and the same quantity of acetic acid as above.

When these plates are dry, three of them are placed face up on a sheet of clean paper, and a pool of a thick solution of Canada balsam poured in centre; the corresponding plate is then put film down upon the balsam, and gradually pressed in contact with the lower film ; the balsam is forced out at the edges, and also any air bells that may form. Now put a weight on, and allow about a week for the balsam to set. The screens are now cleaned with benzine and turpentine, the edges bound, and they are ready for testing.

Testing colour filters is best done by means of a chart, such as is issued with Hubl's book, the spectrum itself not being a good test, because in a spectrum test the pure colours only are used without the interference of white light, which plays such an important factor in photographing, either from nature or from paintings, &c. The

white margin on the chart must in every case be of the same density, and this will be a guide to the correct exposure.

In testing the colour filters, the first thing to be ascertained will be the ratios of exposure. This should be done in a Tallent's Spectroscopic Camera, using either a Lumiére's Panchromatic, a Cadett's Spectrum, or a Mawson B. With any of these plates the ratio with screens, made up as above *ought* to be somewhere about 1 for blue-violet filter, 6 for yellow-green, and 15 for red filter. Many experiments will be necessary before the finally correct one is obtained—*i.e.*, correct for one plate only. Next it will be necessary to get the ratios with the plates that are to be used with the chart, and which alone will give the best colour rendering. Theoretically, we require for the yellow printing plate red and blue to be white, yellow dark, and this would seem to indicate that a plate somewhat sensitive to red would be required; but as in the making of a plate-red sensitive, it is also made sensitive to yellow, and to counteract this yellow sensitiveness we must make up a different filter, which is not worth while, we must fall back upon an ordinary gelatine plate—*i.e.*, a plate sensitive to the ultra violet, violet and blue. With such a plate the blue-violet filter given above allows the red to come nearly up to the blue.

For the red printing plate, the greenish yellow filter is used with a plate which by means of erythrosine has been rendered sensitive to yellow wave lengths of light.

For the blue printing plate and the red screen, a plate sensitive as far up the spectrum as possible is to be used.

In making these tests, all three plates must be developed in one dish, and the factorial method of timing the development used, taking the ordinary plate as the guide, because the other two, being colour sensitive, must not be exposed to the influence of the dark room light at all, or fog will ensue, which will vitiate the experiments altogether. A very suitable developer will be found in ortol, compounded as follows:

No. 1.—Ortol	1 ounce (30 grammes)
Metabisulphite of potash	½ ounce (15 grammes)
Water	70 ounces (2000 c.c)

No. 2.—Potash carbonate	4 ounces (120 grammes)
Water	20 ounces (500 c.c)

Use equal parts of Nos. 1 and 2, factor 10. When the development time has expired, transfer at once into clean hypo without any preliminary washing. After the negatives are dry, silver prints from each, printed to such a depth as to get the white margin of chart just tinted, will give, on comparison with the monochromes sent out, an idea as to how far the screens (or filters) give a correct rendering, or whether the ratio of exposures has been correct.

Using collodion emulsion, and illuminating the picture with electric light, carbons can be used for the arc which give violet or red illumination. The violet flames being used with the blue and green filters, the red flame with the red filter.

With the blue-violet filter use the collodion emulsion mixed with sensitiser (*a*). With the green filter, use the emulsion sensitised with sensitiser (*b*). With the red filter, use the emulsion sensitised with sensitiser (*c*). The exposures will be as 1, $\frac{1}{2}$ and 1.

For illuminating the dark-room, Rheinlander's light filters are to be recommended. For the two first exposures, the red glass in front of dark-room lamp; for (*c*) sensitiser a green light is requisite. Develop with glycin hydrokinone.

CHAPTER II.

*PHOTOCHROMIC PRINTING INKS.**

So much depends on the inks used in photochromic work, that we think this chapter will not come amiss to those of our readers who have to pull proofs of their own work, or who have to give advice to their customers as to the kind of ink to be used.

Although the photochromic three-colour process is adaptable to collotype and lithography, as well as to letterpress, yet, for commercial purposes, at the present time, the half-tone block reigns supreme. And although collotype—as in the monochrome, or ordinary, method—gives the most delicate results in three-colour work, yet it is, at the same time, the most difficult and expensive to work. Therefore we will confine our remarks to the inks used for half-tone plates, although what holds good for these will also hold good, in a general way, for the two sister processes.

For half-tone work only the very best inks should be used. The blocks, on account of their flat surface, take very little ink in comparison with woodcuts or type, and therefore, unless the ink is made of strong pigments of the finest quality, the prints will turn out flat and look washed out.

One of the crucial tests of good photochromic work is the production not only of a correct rendering of the colouring of the original, but of the production of neutral blacks and greys wherever they occur, be it a painting or still-life

* We are indebted to Mr. C. G. Zander's book on "Photo-Trichromatic Printing" for the information contained in this chapter.

object. If the colour-filters are correct representatives of the primary colour-sensations of the spectrum, the resultant negatives will be monochrome representatives of the respective primary colour-sensations reflected from the object. It is necessary in order to obtain a correct rendering that the blocks should be printed in inks which are complementary colours of the colour-filters used. It is obvious, therefore, that as the colours of the three selective screens, if scientifically constructed, are—if we may use the term—a fixture, so the three pigmentary colours used in printing are also a fixture, and cannot be arbitrarily selected. The three pigments which alone produce a correct colouring of a picture produced by the photochromic process are:—A pure red pigment—one neither a purple nor an orange, but the primary red of the artist, *i.e.*, the combination of fundamental red and blue-violet of the spectrum. The yellow ink must be a pure yellow, not inclined either to orange or green, *i.e.*, about the shade of sulphur, or what artists' colourmen call "lemon yellow." The third ink, the blue, must be cyan-blue, somewhat similar to a greenish cobalt blue. Neither the violet nor the green should, however, preponderate in this blue. If these three inks are correctly made, it will, by their mixture, be possible to produce every colour, including tints, saddened hues, and dense blacks. Some ink makers unscrupulously use fugitive aniline lakes for the red, which, after a few days' exposure to light, will fade and render the colouring of the whole picture incorrect. As permanency is desired, alizarine lakes, made of alizarine—which, like aniline, is a coal-tar product—should be employed. It is also found in nature as the colouring principle of madder root, which used to be extremely cultivated in the South of France. Modern artificial madders are perfectly permanent, and can be produced in all shades of red, from scarlet to purple, and in excellent imitations of carmine and cochineal crimson, and scarlet lakes.

Ultramarine is a most undesirable pigment for half-tone photochromic inks, on account of its opacity, and because it does not print flat.

In a photochromic picture the various colours are produced by the superposition of yellow, blue, and red dots of various sizes. Where these dots cover each other they produce a pigmentary mixture, almost identically as if the pigments had been mixed by a palette knife previous to being printed. Where these dots lie next to each other they produce an optical mixture—that is, the eye will record two adjoining dots simultaneously. For instance, red and blue appear as violet; blue and yellow as green; red, yellow, and blue—*i.e.*, the three colours combined—as black (or grey if the dots are small and allow the paper to reflect white light through between the interstices).

These remarks now lead us to the second essential quality of the photochromic inks—viz., transparency. Unless the pigments used are transparent, the pigmentary mixture just alluded to cannot take place. Wherever, for instance, an opaque red dot should cover a yellow one, instead of producing an orange or scarlet, it would only show the colour last printed; but if the red is transparent, it will combine with the yellow to form orange. It is not very difficult to find a red that answers not only to the required shade, but possesses transparency; we find it in madder lake, struck on a transparent base, such as hydrate of alumina. This pigment possesses another valuable property, that of absolute permanency when exposed to sunlight. The blue pigment is more difficult to produce. The best is a cyanine blue, which can be made of the requisite shade, and is transparent. It cannot be called absolutely permanent, but the fading when printed full strength is so slight that it need not be taken into consideration. Artists do not hesitate to use this blue in the most valuable pictures. Ultramarine must be rejected on account of the reasons already mentioned, and aniline blues are much too fugitive. The most serious difficulty presents itself in the selection of the yellow. Up to now the non-success of producing an absolutely permanent transparent yellow necessitates the use of an opaque pigment, and printing the yellow first. If this is done, it does not matter if an opaque yellow pigment is used so long as it is permanent and of the requisite

shade. It is also advisable to print the blue last, on account of its possessing the smallest luminosity. But for these two reasons it would not matter in what order the colours are printed. So it is necessary to print them in the order of yellow, red and blue.

It need hardly be mentioned that it is of great importance that the pigments should be well proportioned as regards their colouring power. If that is not so, it will be found that the strongest pigment causes the picture to be coloured with a preponderance of that particular colour, which is generally the red. Placed in Lovibond's tintometer, it will be found that the yellow and blue pigments are of about equal strength (about seventeen units each), whilst the red pigment, if madder, will measure probably thirty-four units, or about double the strength. It is, therefore, necessary that the printing ink maker should proportion the strength of the pigments if correct colouring of the picture is to be expected.

Use good paper only—hard, well-sized and glazed—and in printing use hard packing, eight or ten sheets of cream wove paper. It will then not be difficult to print from blocks of very fine grain, and the colours will appear much cleaner and brighter. No pains should be spared, either, in the making-ready of the blocks.

PART VII.

PHOTOGRAVURE.

CHAPTER I.

INTRODUCTION.

THE production of a photogravure print may be divided into six stages (the negative, of course, being already made).

FIRST STAGE.—From the negative a transparency is made upon the special (transparency) carbon tissue, developing upon a prepared glass plate. Transparencies upon dry plates, unless made otherwise than by contact, cannot be used, unless a reversed negative be used. If made in enlarging camera the reversal of the image can be provided for.

SECOND STAGE.—Laying the etching ground upon a polished copperplate (conferring the power of holding the ink upon the copperplate) by dusting over with finely-powdered resin, or asphaltum, or by the air-brush, &c.

THIRD STAGE.—From the transparency a negative in ordinary carbon tissue is made, for development upon a prepared copperplate ; this carbon negative forming the resist in the etching bath.

FOURTH STAGE.—The carbon image (second stage) is mounted and developed upon the prepared copperplate (third stage), and dried thereon.

FIFTH STAGE.—Protecting the margin, and etching in a solution of perchloride of iron, or of dilute nitric acid, then cleaning off the resist, and burnishing the margin and high lights when necessary.

SIXTH STAGE.—Printing from the plate, much in the same manner as copperplate etchings and mezzotint engravings are printed.

After the plate is proved, and retouched with burnisher and roulette, if many impressions are required, it should be steel faced—an operation not necessary for small numbers, and which amateurs may dispense with if preferred, and when one plate is worn out make another.

The apparatus required up to and including the fifth stage will be already in ordinary use (excepting that required for the third stage), except perhaps a squeegee for mounting the carbon tissue upon the glass and copperplates, and which, by-the-bye, it will be as well to mention, must be a genuine squeegee of indiarubber for scraping pressure, not the useless rollers foisted upon amateurs as squeegees.

Carbon tissue (ordinary and special), bichromate of potassium, powdered resin, asphaltum, black varnish, washed whiting, washed emery powder, a mixture of equal parts vegetable naphtha and turpentine, plenty of clean soft rags, with bevelled and polished copperplates, comprise the materials used.

For the sixth stage, a copperplate printers' plant will be required, consisting of a copperplate press fitted with two blankets the size of bed-plate, one end being hung over the projecting pulley, the end of string being weighted with a piece of lead so as to lift the end of blankets from the plate when returned under the roller; a heater for warming the plate, consisting of an iron plate upon legs, with an atmospheric gas-burner underneath, or, if gas is not available, a paraffin stove may be used; a jigger, a box with the end open, the top being used as a bench upon which to slide the hot copperplate from the heater during the operation of inking up, the body of jigger holding a ball of whiting upon which the palm of the hand can be wiped, also as a receptacle for wiping rags, ink-dabber, &c.; an ink-dabber or two made of flannel, rolled tightly, about $1\frac{1}{2}$ inches in diameter, and 4 inches long, the loose end being sewn to the body of roll; a strong flexible palette knife; an inking slab, either an old litho stone or a plate of smooth zinc screwed down upon a wooden block; copperplate ink; pigments in powder for modifying the ink in colour or in

consistency; burnt oil, strong and medium; a bottle of turpentine; Plate, India and Japanese paper for printing upon; a sponge for damping the paper, a burnishing tool and a roulette or two.

CHAPTER II.

PREPARING THE NEGATIVE.

THE negative it is intended to make a photogravure plate from must be of the very best quality, free from blemish, well exposed, full of detail in lights and in shadows, strong without hardness, soft without flatness; from hard, under-exposed negatives, it is useless expecting to get results in any way approaching satisfactory, therefore such negatives should not be tried. Flat, over-exposed negatives may be improved by reproduction, making a transparency from it in carbon, intensifying the carbon image by flooding with a strong solution of permanganate of potash, and from this transparency making a negative by contact on a slow dry plate, such as Mawson's photo-mechanical plate, or making another negative in the enlarging camera.

In making negatives from carbon transparencies upon dry plates in contact, the best plan is to put the transparency into the dark slide film up, after cleaning the back and dusting the front; then put a dry plate upon the transparency, film down, and close the dark slide—if a double slide is used, some soft packing will be required to keep the two in close contact, which packing must be dark in colour.

The dark slide containing the transparency and sensitive plate is put into the camera, the lens of which is racked out of focus, and is pointed to a large sheet of white paper evenly illuminated, or pointed to the sky, when the exposure is made; the plate is developed by the operator's

pet formula. By this means the reproduced negative, being exposed to the parallel rays projected by the lens, is quite sharp, the relief of the carbon tissue and the inequalities of the two glass plates being rendered innocuous.

If the negative is larger or smaller than the projected photogravure print, the carbon transparency must be placed in the enlarging camera, and a negative made from it by daylight the exact size required. When the original negative is too large, or too small, and is of the desired quality, instead of making a carbon transparency, the negative (with the subject required duly masked) may be placed in the enlarging camera, the film away from the lens, and a transparency made therefrom the size required, using a slow dry plate, giving a full exposure, developing with a well-restrained developer, so as to obtain clear lights and strong shadows, the transparency when finished being very much too dark for lantern purposes.

When the original negative is the exact size required, the transparency should be made in carbon, as that process gives a far better chance of a successful result. For this purpose the special transparency tissue is used. The word "special" has nothing to do with photogravure, but is the generic name given to a carbon tissue made for transparencies, containing a special pigment, more finely ground, and present in larger quantities than is the case in ordinary carbon tissues intended for paper prints. Carbon tissue should be purchased ready sensitised, and in cut sizes, as the operation of sensitising requires proper appliances and experience in the work. Carbon tissue sensitised will keep good for a month if kept dry, and, of course, away from light.

Before exposing the sensitive tissue to light under the negative, a mask must be cut and placed on the negative, so that the edges of the tissue are protected from the light. If this is not done, the tissue will not attach itself to the support upon which it is mounted previous to development by hot water. This shielding the edges is usually called the safe-edge.

As a photogravure print looks so much better with a

good margin between the edge of picture and the plate mark, this, in conjunction with the safe-edge for the carbon prints, will be likely to lead to confusion unless definite measurements are given. Therefore, to avoid mistakes and to simplify matters, we will assume that a negative measuring 5 inches by 4 inches has been selected for the first trial in photogravure, and upon this assumption all dimensions given will be based; the dimensions, however, will of necessity be modified by the student to fit his own negatives, and the amount of subject required in the picture.

CHAPTER III.

THE CARBON TRANSPARENCY.

First Stage.

To prepare the negative for making the transparency, first of all thoroughly clean the back, then in a piece of thin opaque paper cut an opening $4\frac{1}{2}$ inches by $3\frac{1}{2}$ inches, place this in position upon the glass front of a half-plate printing frame, place the negative in position upon this mask, now put a piece of transparency tissue 5 inches by 4 inches, or larger, upon the negative, black side next the film or negative, put in the usual backing, fasten up the frame, and expose to diffused light.

The exposure to light should be from twice to three times as long as that requisite for making a print from the same negative upon albumenised paper, as the details in the lights must show by transmitted light.

When the exposure is complete, remove the tissue from the frame and immerse in a dish of clean cold water. At once examine back and front for air-bells, which must be removed if formed. Soon after immersion the tissue will curl inwards, this curl as quickly relaxing, and presently the tissue will lie flat on the water. Just before this happens, slide a gelatinised plate —prepared as below— under the tissue. Lift the plate and the tissue from the water, the black face of tissue being in contact with the gelatinised side of plate. Lay the plate upon the bench and squeegee the back of tissue vigorously first one way, then the other, so as to expel all water and air from

between the two surfaces, and so cause the tissue to adhere to the glass plate by atmospheric pressure.

Let the plate stand for five minutes, then immerse in water at a temperature of 100° Fah. Allow it to remain in here for five minutes, then gently lift away the paper. Rock the dish, and if the water has got below 90° add more at 100°, and keep at this for ten minutes. Then lift out the plate and lave with the water until all the soluble pigmented gelatine is removed, then pour over hot water from a jug and give a final rinse with cold water.

Now examine the result, and if the image is free from blemish, and just a little darker printed than would be desirable in a paper print, the transparency may be put away to dry.

If the exposure has been too short, and details are wanting in the lights, or it is too dark and the shadows are choked, or there are any imperfections in it, let another be done at once, as until a perfect transparency is obtained it will be utterly unless proceeding further. In case of failure with the first, utilise the experience gained in getting a perfect result next time.

To prepare the glass plates upon which the tissue is mounted, get some half-plates or larger; spoilt negatives will do, if free from scratches. Clean them by soaking, first in hot solution of washing soda to remove the films. Then, after rinsing under the tap, and well scrubbing, immerse in weak acid. Again wash well, and whilst wet flow over a hot solution of

Gelatine—Nelson's No. 3 flake	1 ounce
Bichromate of potash	30 grains
Water	20 ozs.

Soak the gelatine till soft, then place the jar in a pan of cold water, put upon the fire and melt the gelatine; add the bichromate in fine powder, stir until dissolved, then filter.

The plates when coated are placed on a rack to dry, and when dry are exposed to daylight for five or six hours, to render the film of bichromated gelatine insoluble, after

which the plates may be stored away, they keeping any length of time.

When the transparency is quite dry it is placed upon the retouching easel, and any spots or pinholes present are carefully filled up with a fine sable brush and Indian ink ; then, if any of the details would be better for a little touching, the student can now show his artistic abilities, and lift his work from a mere photographic transcript to an artistic picture.

Until the student is able to judge the effect of such retouching, it will perhaps be best not to do much on the first plate, but there is an undoubted power in the hands of a competent artist to greatly improve upon the original negative in many ways, especially in the direction of correct light and shade.

The transparency may be made upon a process dry plate by contact from a reversed negative, or upon a slow ordinary plate in the enlarging camera, keeping the result bright and clear with a slight deposit upon the highest light.

CHAPTER IV.

LAYING THE GROUND.

Second Stage.

The copperplate to form the intaglio block from which the prints are to be made, must be thoroughly cleaned and polished, then a ground laid upon it to give an ink-holding grain to the surface.

The size of the plate to be used for the picture, 4 inches by 3 inches, will be what is called large 16mo, measuring $5\frac{1}{2}$ inches by $4\frac{3}{8}$ inches ; the edges should be slightly bevelled, and the surface well polished, such plates being sold for the purpose.

Lay the plate upon the bench, sprinkle the surface with a little of washed whiting, moisten this with a little of a mixture of equal parts of vegetable naphtha and turpentine ; polish thoroughly with a piece of clean lint until the whole is quite dry and bright.

The copperplate must be thoroughly polished, and quite free from scratches. Therefore do not hurry over the operation, but take great care and polish well.

The plate being polished, the edges and back entirely freed from all traces of whiting, it is then ready for laying the etching ground.

For this purpose a dusting box is required, of which two patterns are to be obtained ; in one pattern the box is made to revolve bodily in order to create a dust in the other and better pattern ; the body is not moved, the dust being created by revolving brushes (Fig. 29).

To use this box, put into it a pint of very finely-powdered asphaltum, close the door, and revolve the box rapidly for a minute or so, then return to its original position. Let it rest for a minute to allow the coarser particles to subside. open the door and place the polished copperplate, which rests upon a larger glass plate, upon the grid, then close the

FIG. 29.—DUSTING BOX FOR LAYING THE GROUND.

door, and leave the plate for five or ten minutes. Upon removing the plate from the box it will be found entirely covered with a thin film of very fine dust, and care must be taken not to subject the plate while in this condition to a draught, or the dust will be displaced, and the effect spoilt.

Directly the plate is removed from the dusting-box it is placed upon the heater, the temperature of which should be about 150° Fah., and allowed to remain until the dust is melted just sufficiently to adhere to the copper. Here very great care is required. The plate must not be subjected to too great a heat, or allowed to remain too long upon the heater, else the asphalt will form a homogeneous film, instead of a collection of very fine particles, through the interstices of which the etching fluid can penetrate.

Copperplates so prepared will keep any length of time, so, if more convenient, a number may be prepared at once for future use. This ground will require variations to suit the subject. A short time in the dusting box will leave only a small quantity of the resist; a longer time, more. The illustrations (Figs. 30, 31, 32 and 33) showing four different degrees of dusting, will make this clearer, the examples being micro enlargements from the grains, the enlargement being one hundred times.

There are other methods of laying the ground, one by means of the air-brush, the spoon being filled with a solution of asphaltum, or of a resin in turpentine, or any suitable solvent; a scent spray with the two bulbs may also be used for this purpose, charging the bottle with a filtered solution of asphaltum, or of a resin, or gum in turpentine, or spirits of wine. With either of these spray methods the operator has a great power of altering the size of the grain, both generally all over the plate, as well as locally, and either of them are well worthy of trial. Grounds laid by these spray methods require no heating, as the solvent in evaporating leaves the resin, or gum, or asphalt in the proper condition to resist the acid and to allow the carbon negative being mounted thereon. The proportion of gum, resin or asphalt should be as near saturation as possible, and the solution must be filtered before use, or the passages will be clogged, and the action stopped.

The old methods for laying the grounds for aqua tint engraving, with solutions of resin in spirits of wine, are as follows: In a corked bottle make a saturated solution of the best white resin in strong spirits of wine, allowing some

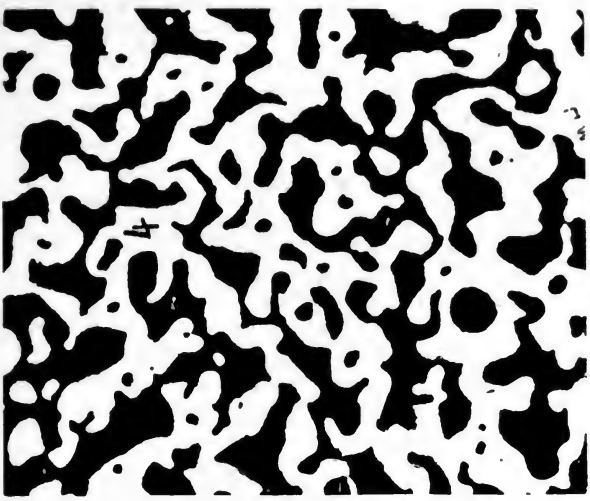


FIG. 31.—FOUR MINUTES' DUSTING.

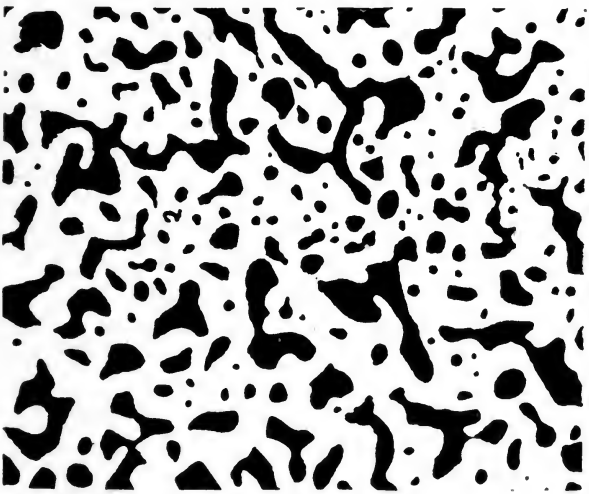


FIG. 30.—TWO MINUTES' DUSTING.

days, with occasional shaking, to get complete saturation. Now have two other bottles ready, and label them No. 2 and No. 3—the one containing the resin solution being No. 1; into No. 2 bottle put one ounce of solution from No. 1 and two ounces of spirits of wine; into No. 3 half-an-ounce from No. 1 and two ounces of spirits of wine.

The spirits of wine must be quite free from water, and to ascertain this, place a small quantity of gunpowder into a spoon, mix this with a little of the spirits, and ignite; if the powder explodes, the spirit is good, but if it remains at the bottom of the spoon, black and wet, water is present, and the spirit is useless.

To try the solutions, pour a little of the liquid from each bottle (draining each lot back into its own bottle) upon the plate, then lay it horizontally until the spirit has evaporated; then, with a magnifying glass, examine the three deposits of resin, and judge the size of grain suitable for the purpose. If none are satisfactory, other mixtures in different proportions of spirit and solution of resin may be made. To lay the ground, the plate must be polished and held over a dish. The resin solution is then poured over at one steady sweep, and when all the surface is covered the plate is put on a level surface to dry; when dry, the plate will be in the same condition as the dusting method after melting the dust.

Another method of laying the ground is to make a five per cent. solution of camphor in methylated chloroform, and a five per cent. solution in white resin in benzole, mix, then coat the polished plate, and dry in a level position; when dry, put upon hot plate until the camphor ceases to smell, and the resin begins, then cool, and the ground is ready.

Another method is to oil the copperplate with olive oil, then to dust over with flour of sulphur, and allow to remain a few hours, when a slight tint will be etched all over the plate, more or less deep in proportion to the time given. These plates must be cleaned with ammonia before the next stage.

Bay salt	2 parts
Ammonium chloride	1 part
Verdigris	1 part

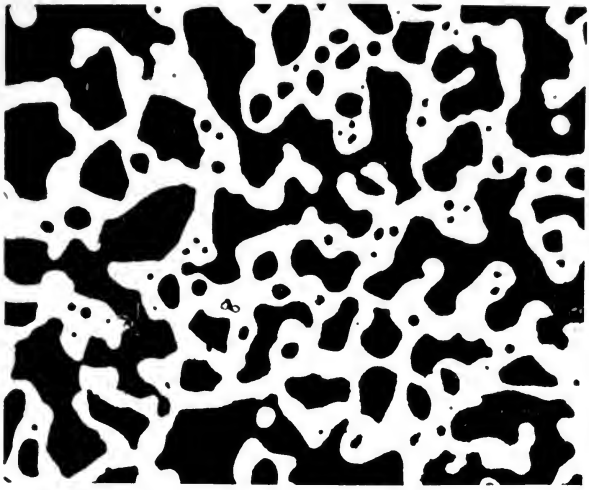


FIG. 33.—EIGHT MINUTES' DUSTING.

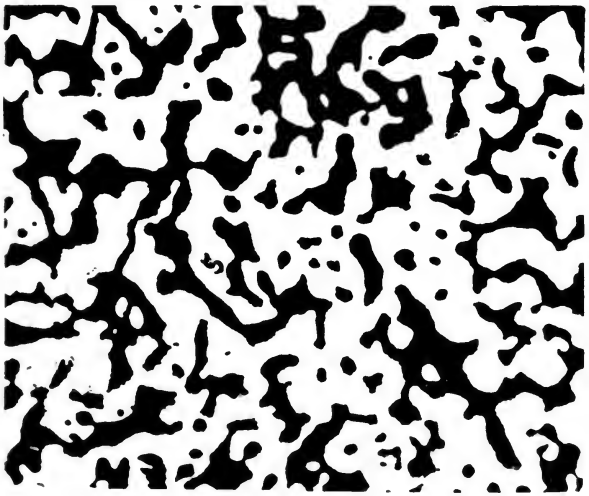


FIG. 32.—FIVE MINUTES' DUSTING.

ground into a fine powder, mixed with a syrup of honey, also gives a good grain, and may be used after etching to vary the tints.

The old mezzotint ground laid with an instrument called a cradle, and a roulette also can be utilised, and offers the artist many methods of giving individuality to his work.

Another ground may be laid by developing upon the clean copperplate a carbon print from negative made from a cross-lined screen, such negative being made with plate almost in contact, using a small round stop in the lens, which is pointed at a sheet of white paper ; give an exposure sufficient to get the dots as large as possible, keep the lines clear, and the dots opaque.

CHAPTER V.

THE CARBON RESIST.

Third Stage.

The transparency being retouched, a mask is cut $4\frac{1}{4}$ by $3\frac{1}{4}$, and upon this mask lines are drawn $\frac{1}{4}$ inch away from the edge all round. Put the transparency into the printing frame, and upon the transparency place the mask in position, pencil lines uppermost getting the image in the centre of the mask opening. Now cut a piece of carbon tissue (either ordinary or made specially for Photogravure), $4\frac{1}{2}$ by $3\frac{1}{2}$, and put this, face down, upon the negative and within the pencil lines on the mask, so as to get the image exactly in the centre of the tissue ; the frame is fastened up and exposed to light, timing the exposure by means of either Johnson's actinometer or Watkins' print meter.

If printing on carbon tissue is a new process to the student, it will be as well to experiment with a few prints, developing upon glass until a certain degree of proficiency is attained.

As a guide for exposure, from four to eight tints, with a Watkins' print meter, will be a good average to start from, increasing or decreasing as required. Whilst the tissue is exposing, the copperplate, upon which it will be subsequently mounted, must be prepared, as directed in the chapter previous.

The tissue under the transparency being exposed, it is removed from the printing frame and placed in cold water, and when the curl relaxes it is squeegeed down upon the

prepared copperplate. When thus mounted, place under a weight for a few minutes ; then immerse in warm water at 95° F. until the paper backing is loosened, so that it can be stripped off ; then add more hot water, and lave the plate until the whole of the soluble pigmented gelatine is washed away, raising the temperature of water to 110°, if necessary, on account of over-exposure in the printing frame. When properly developed, rinse under the tap, then put away to dry.

Great care must be taken in mounting the exposed tissue upon the prepared copper to avoid air bells between the carbon film and prepared surface. See that the prepared surface of copper is thoroughly wetted, and also be certain no air bells are attached to the tissue. Neglect of these precautions will result in the formation of devils, and this is the sole cause of such defects.

When the carbon image is dry, the margin of bare copper is carefully covered with either black varnish, or with thick spirit varnish laid on with a brush, great care being exercised not to encroach upon the picture. When this is dry, the plate is at once placed in the etching fluid, consisting of a solution of perchloride of iron, showing a strength of 45° Beame, in about two or three minutes (the temperature being about 65° F). There should be a slight discolouration of the copper underneath the thinnest portion of the image representing the deepest shadows ; pour off the solution, and replace with another of 42° Beame ; this will discolour the copper under the shadow half-tones, requiring, perhaps, three or four minutes to do so. This solution is then poured off, and another of 36° Beame applied ; this will etch the middle tones, and require about three minutes to act ; then pour off and apply a solution at 32° Beame, which will in about one or two minutes discolour the metal underneath the denser portions of carbon resist, which, being a negative, represent the highest lights of the picture, and, being the thickest, are etched the last. Watch the result carefully, and as soon as the whole of the protected copper underneath the carbon image is discoloured by the perchloride of iron, at once remove the plate,

wash well, and, with a brush dipped in a strong solution of carbonate of soda, clean off the whole of the resist. The operation of etching only occupies a few minutes, and must be closely watched, the action being traced by the discolouration of the metal, first in the shadows, then the half-tones, and finally the lights,* at which point the action must be at once stopped.

The strength of the etching bath is only approximate; some pictures will require the use of stronger, others of weaker solution. The stronger the solution, the slower the action; therefore the best way is always to begin with a strong bath, and using weaker ones as the action stops at the various tones or different thickness of carbon image.

This etching must not be looked upon as a deep etching, because it is not so; really it is nothing more than a roughening of the surface sufficient to imprison the stiff ink used for printing.

If a copperplate, when the ground is laid, be immersed in a weak alcoholic solution of perchloride of iron, and the dish rocked for ten or fifteen minutes, the plate washed in turpentine and cleaned, if inked up with copperplate ink, would yield a black tint, much the same as a very fine chalk or crayon tint. And it is this tint, broken up by the varying thicknesses of the gelatine in the carbon image into lighter or heavier masses, which forms the ink-holding surface of the photogravure plate; but of actual depth there is none. Photogravure in this respect is very much like the old mezzotint process, in which the print is built up by the varying depth of the ink, the image being produced upon the plate by scraping and burnishing, to make the half-tones and high lights from the shadow ground.

Nitrous acid	1 part
Water	10 parts

or

Nitric acid	½ part
Water	12 parts
Alcohol	5 parts

* Note that in the carbon resist the shadows are transparent and the high lights opaque.

may be used for etching instead of perchloride of iron, but as they do not colour the copper, they are more difficult to manage by beginners.

When the plate is etched, the resist and varnish are at once cleaned off, the margin polished with fine emery cloth, protecting the picture with a thin straight-edge, then a proof must be pulled so as to see if any improvement can be effected with burnisher or roulette.

CHAPTER VI.

PRINTING FROM THE PLATE.

THE next operation will be to pull a proof from the plate, to do which it will be necessary here to give full instruction for printing from intaglio plates.

We now require a copperplate press. (See Fig. 84.)

Fitted with two blankets, a thick one next the rollers, a thin one underneath, and a piece of millboard on the bed of press, upon which to lay the plate. The blankets are generally hung up by a string passing over the pulley A, and weighted so that the blankets are raised as the pressure is removed.

For photogravure plates the ink must be strong, both in colour and in oil, being mixed by grinding with a stone muller on a slab. Frankfort black is easily ground, Paris black being brighter and harder, any desired modification being obtained by the admixture of burnt sienna, or burnt umber, or of lake and Prussian blue. The ink is applied by a dabber made from a roll of cloth or flannel, about 4 inches long and 1 inch in diameter. For finishing plate, two grades of muslin will be required, coarse for wiping the plate and soft for finishing.

The best coarse muslin is of French manufacture, and is sold for the purpose. For finishing, any fine muslin may be used.

The paper upon which the proofs are to be pulled should be a good plate paper, and each sheet must be damped by rubbing over with a clean wet sponge, and stacked for a few hours under a weight.

The heater must be connected by means of indiarubber tube with a gas supply. (See Fig. 35.)

The jigger is a small box serving as a table, as a receptacle for a ball of whiting, and for the various cloths, &c., used in preparing the plate for the press.

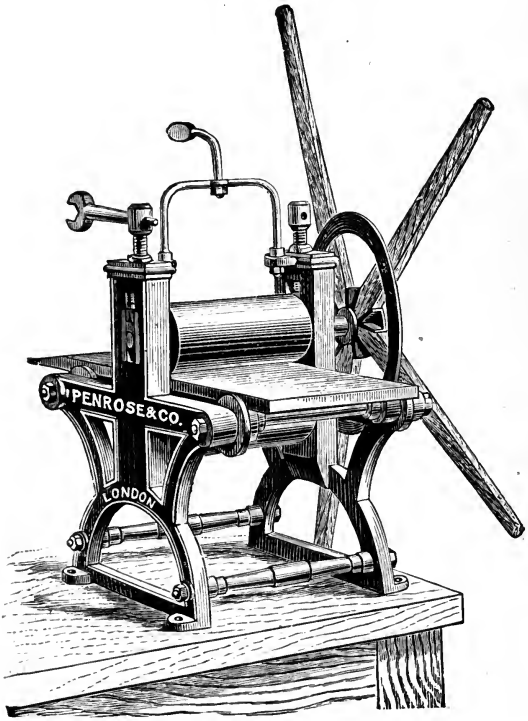


FIG. 34.—COPPERPLATE PRINTING PRESS.

The student will find it greatly to his advantage at first to purchase his ink ready for use; and by-and-bye, when proficient at the whole process, he will better understand the method of preparing it. To take a proof, the plate is well cleaned, first with a mixture of turpentine and naphtha,

and wiped dry. It is then placed on the heater, and allowed to remain until just a little warmer than the hand can bear. Whilst this is being done, take a dab of ink out of the can and put on the slab ; dip the end of dabber in the ink, and work it on the slab. When the plate is sufficiently hot, place it on the jigger, protecting the fingers with a piece of cloth. Dab all over with the ink, working it well into the engraving.

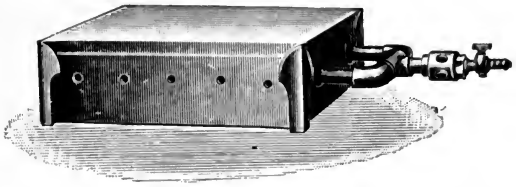


FIG. 35.—HEATER FOR PHOTOGRAVURE PLATES.

Now with a pad of coarse muslin, warmed, wipe the plate gently, so as to remove the ink from the margin and whites. Then make a cushion of three or four ply of fine muslin, just large enough to lay on the palm of the right hand. Warm this muslin, and proceed to wipe the plate with light pressure round and round until ink is only left in the depths of the picture.

The cushion of muslin gradually charges itself with ink, and consequently the surface of plate cannot be entirely cleaned, the cleanest parts having a thin tint upon them, and it is now that the printer can exercise his judgment as to which portions are to be white. The finger clothed in a piece of fine muslin, or a pencil of wood, or an ordinary stump, may be used to give special prominence to any desired portion of the picture.

The ink when cold adheres strongly to the plate ; therefore it, and the muslin, must be kept warm in order to ensure even wiping.

The plate being wiped, the margin and bevelled edges are cleaned with a rag dipped in turpentine. The plate

is then put on the press, a piece of damp paper in position, the rollers revolved, and the print is made.

Remove the plate from the press, and slightly warm upon the heater before removing the print.

This printing from the etched plate is not a very easy one, so the student must expect to be some time before he can turn out a really good pull from his plate. When a good pull has been obtained, it should be carefully examined, and if the picture is deficient in the high lights, a burnishing tool (judiciously used) will soon remedy this defect, the shadows being strengthened by means of a roulette, but do not touch the half-tones. When the plate has been proved, the next operation will be to steel-face it, for which purpose it is thoroughly cleaned with whiting moistened with turpentine and naphtha, polishing with a soft cloth ; a small portion of the plate behind is scraped clean, and a piece of copper wire soldered to it. The steeling solution is placed in a wooden cell, the positive and negative poles for the battery (Leclanché) ending in copper rods the whole length of the cell. The solution is composed of

Warm water	20 ounces
Ammonium chloride	3 ounces
Sulphate of iron and ammonia	4 ounces

When dissolved filter, and let it stand in the cell twenty-four hours before use. When required for use, the copperplate is hung upon the rod connecting with the negative pole of battery, the positive pole being occupied by the anode (a plate of pure steel), which must be the same size, or larger than the copperplate. The two plates being in position, the current is turned on by pushing in the rod of battery, and in from three to five minutes the operation is complete, the copperplate being covered by a very thin film of steel. The plate when steel-faced is thoroughly washed and dried, and then cleaned with whiting and turps and naphtha, the copper wire behind carefully unsoldered, and the back scraped flat. If the battery is not to be used again for some time, the anode should be removed and wiped dry, the cell being carefully covered up.

A photogravure plate is very shallow, and requires a very strong ink to give the requisite depth in the print. Therefore it will be very essential that the student should be able to mix his own ink. To do this a muller and slab must be obtained, together with oil, strong and medium, and the various pigments, the ink being made by grinding the pigments in the oil, on the slab, with a muller. For a strong ink the maximum of pigment is ground with a minimum of strong oil, the grinding being incomplete unless every particle of pigment be incorporated with oil.

For printing proofs on India paper, a piece of India paper is placed on the inked plate, the thick plate paper well damped being put upon the India paper, and when the impression is pulled, the India paper adheres to the plate paper. Be very careful in warming the plate after pressing, and lift the print away carefully.

Prints are dried separately; then, when both ink and paper are quite dry, damp again slightly, lay tissue paper between each, and place under a weight until again dry.

Titles may be put by covering the whole plate with a thin film of bitumen varnish, then writing the title with an etching needle (writing backwards of course), taking care that the needle goes right through the varnish; now immerse for a few minutes in the etching solution, clean off the resist, and the plate is ready for printing.

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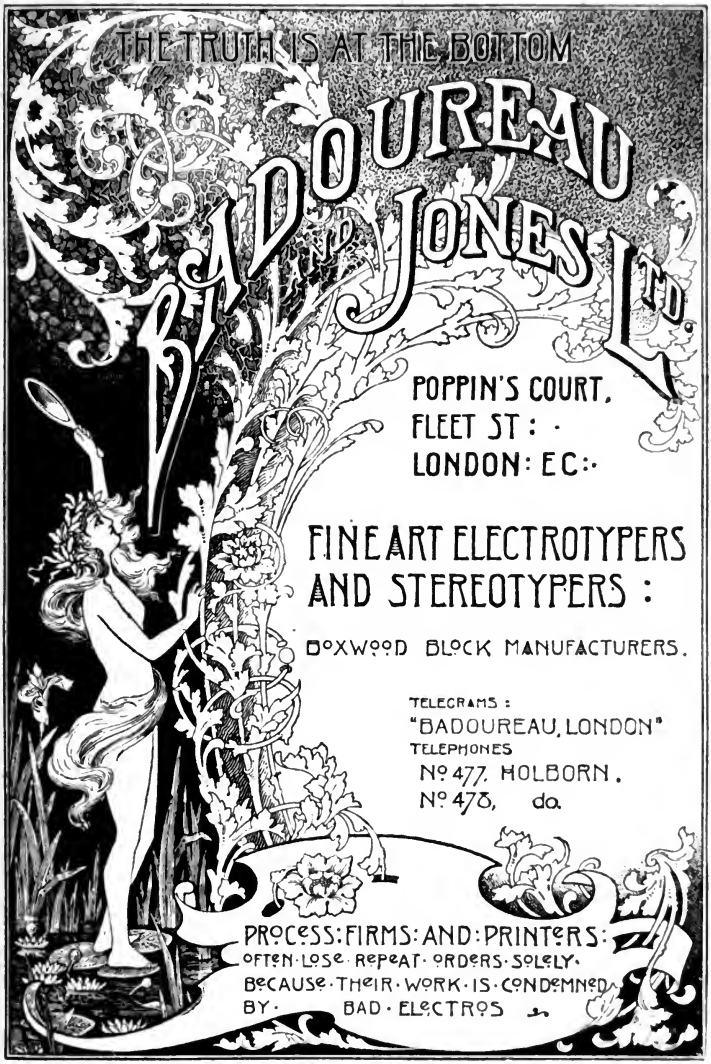
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